

POPULAR SCIENCE

MONTHLY

JULY 1946
25 CENTS



Wind at Work for Tomorrow's Planes

p. 66



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electrical pipe-line →



Microwaves make their journey from apparatus to antenna not by wire, cable, or coaxial—but by waveguide.

Long before the war, Bell Laboratories by theory and experiment had proved that a metal tube could serve as a pipe-line for the transmission of electric waves, even over great distances.

War came, and with it the sudden need for a conveyor of the powerful microwave pulses of radar. The metal waveguide was the answer. Simple, rugged, containing no insulation, it would operate unchanged in heat or cold. In the radar shown above, which kept track of enemy and friendly planes, a waveguide conveyed microwave pulses be-

tween reflector and the radar apparatus in the pedestal. Bell Laboratories' engineers freely shared their waveguide discoveries with war industry.

Now, by the use of special shapes and strategic angles, by putting rods across the inside and varying the diameter, waveguides can be made to separate waves of different lengths. They can slow up waves, hurry them along, reflect them, or send them into space and funnel them back. Bell Laboratories are now developing waveguides to conduct microwave energy in new radio relay systems, capable of carrying hundreds of telephone conversations simultaneously with television and music programs.

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Actually, this most publicized and expensive of experiments is hardly a realistic military test. Certainly, it is not a scientific test of atomic destruction. For it rests on the naive simplification of dropping one bomb at a time.

Forgetting, if we ever can, the enormous international dimensions of the atom bomb, this single-shot thinking is frightening. It fails to include such immediate and visible devices as the V-2. Those who saw this ominous engine

shudder upward from the earth at White Sands, New Mexico, were plain scared. Even those who saw the thing in the safety of a movie theater were horrified.

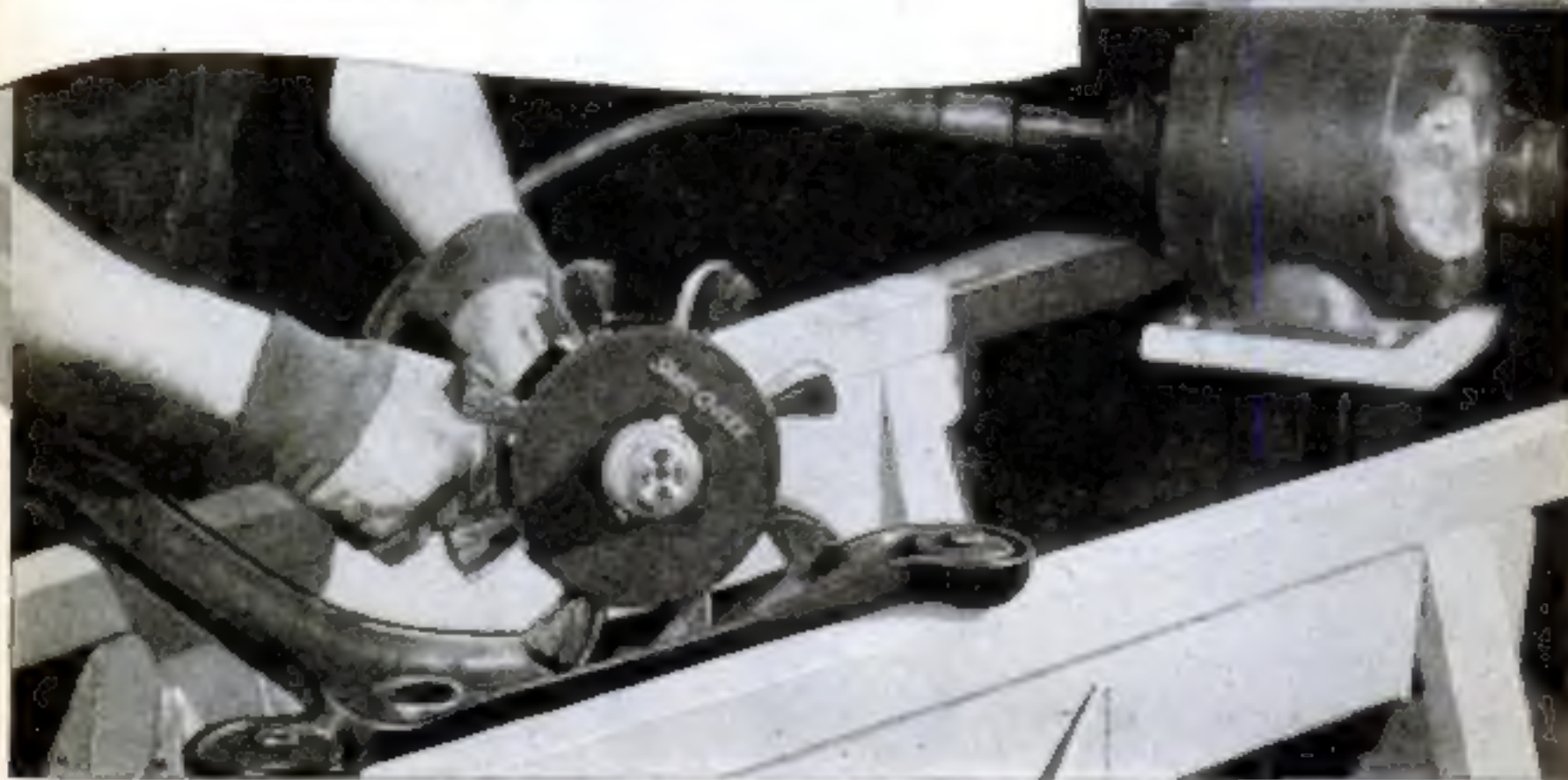
You don't need much imagination to picture a thousand V-2s loaded with coiled atoms, which would make a near-miss a widespread devastation wherever they struck. A "first line of defense" would not have much to defend after that. That is why the scientists who have been closest to the atom bomb are the most frightened of men. They know that man has finally created a weapon for which man can find no final defense.

And that is why the Bikini experiment, whatever its outcome, is a dangerous diversion in the painful process of adapting the most warlike of animals to the brutal necessity of survival through peace.

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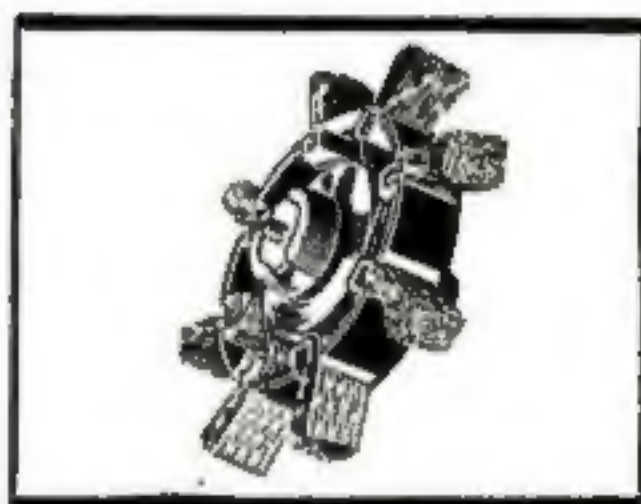
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In June 1942 I was interned as a civilian and put in jail under strong guard. But after three or four months I was lucky enough to get a chance to smuggle a letter out of camp to my wife, still free at that time. I asked her to send me six issues of *Popular Science*, bound in one volume. She did so—and it was not easy to slip it past the Jap guard. But again I was lucky; I got my book and managed to hide it for more than a year.

Sometimes I slept on it, using it for a pillow. Once, during an inspection, I slipped it into a pillow case and hung it on the line with some wet laundry. The Japs didn't find it. But, in moving from one camp to another, my book was finally discovered and I was punished for having it in my possession. A Jap guard hit me very hard.

For more than a year we had had it, and I assure you we really read it. . . . it was like an oasis in the desert and for hundreds of internees it provided a most welcome diversion. . . . We even copied many of the articles in very fine writing on cigarette paper, which was easy to hide. . . . A lot of the articles were subjects for meetings of eight to 10 internees at a time. We discussed the material and talked of experiences of our own that had bearing on the subject matter. For the youngsters this was very educational. . . . and the older men enjoyed it.

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PSM's article on safe driving caused wide

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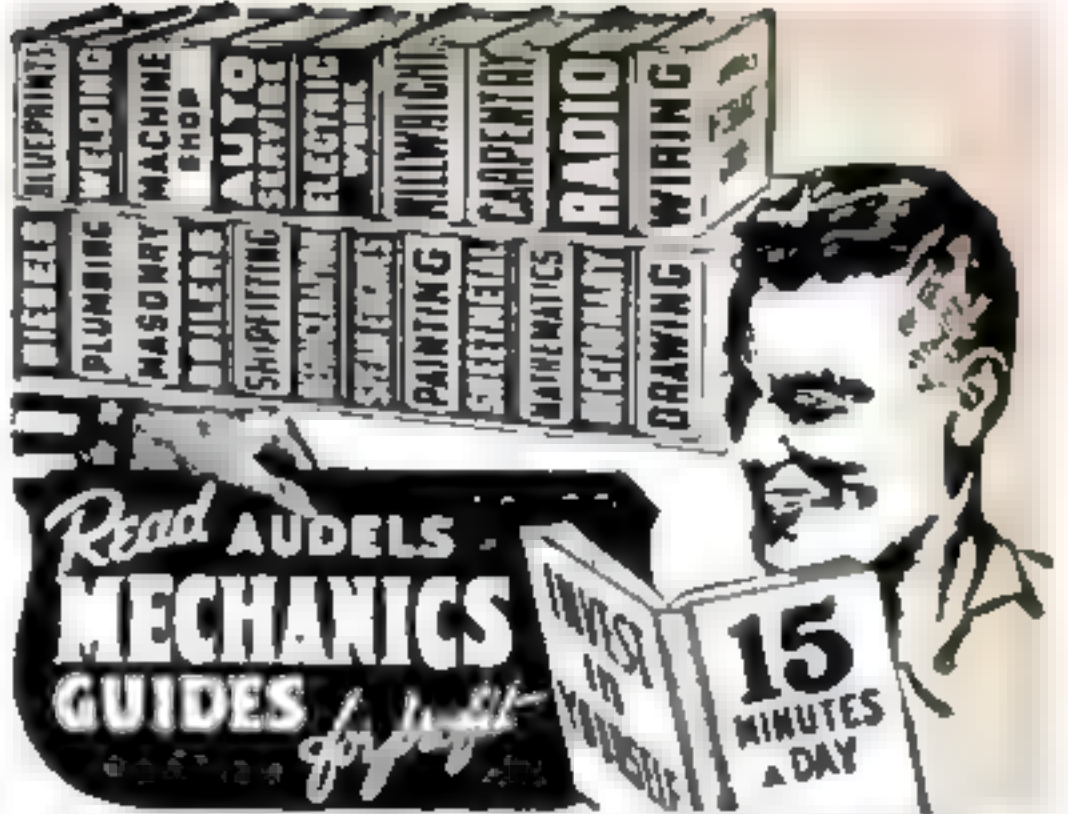
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F/SGT. RONALD FARRIMOND
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Southeast Asia Air Forces

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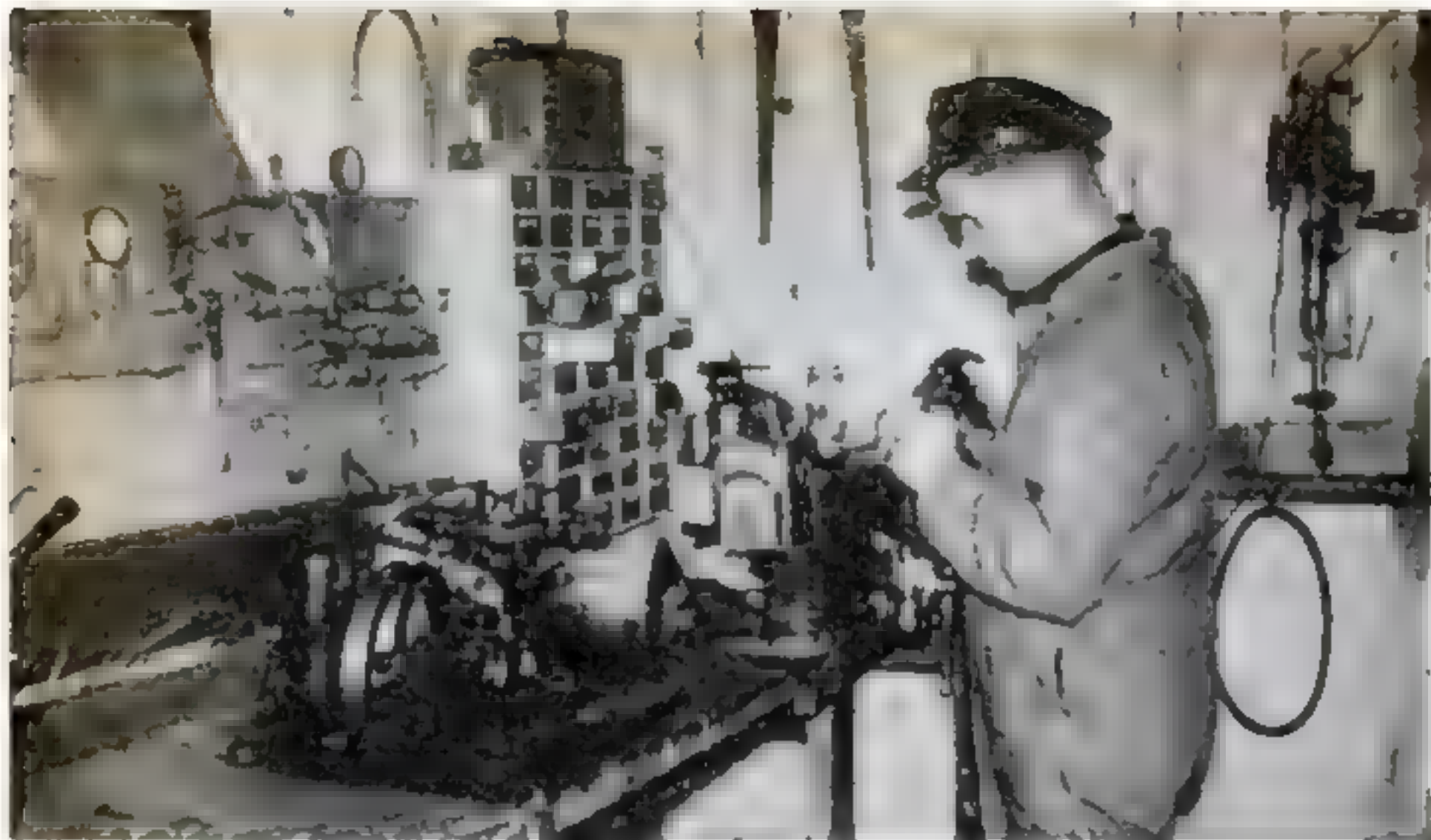
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By S. T. CHRISTENSEN

the "Fix-it Man"

"**W**ELL, I guess I'm the fellow to see, for I've repaired thousands of refrigerators (home and commercial both), vacuum cleaners, radios, washing machines, irons, fans, lamps, mangles, motors, etc. In fact, many of my customers call me their "electrical appliance doctor." And "doctoring," I might add has paid me a good substantial income for quite a few years. Funny, in a way, how I got started. Always liked to tinker and by experimenting around I found that most electrical appliances had many things in common. That, regardless of what the appliance was used for, or who the manufacturer was, the basic principles were much the same. From fixing my own appliances to fixing friends' and then for strangers at a fee, seems now to have been but a small step.

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At first, I let the owner decide the charge and, frankly, I was amazed at what I earned per hour. But then, when one figures what initial costs are involved in buying most electrical appliances, one can readily see that spending extra dollars for repairs is well worth while. Before long I was making more in my spare time repairing than from my regular job. The result . . . I went into business for myself. When war came, business boomed, for new appliances were not available.

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ADV.



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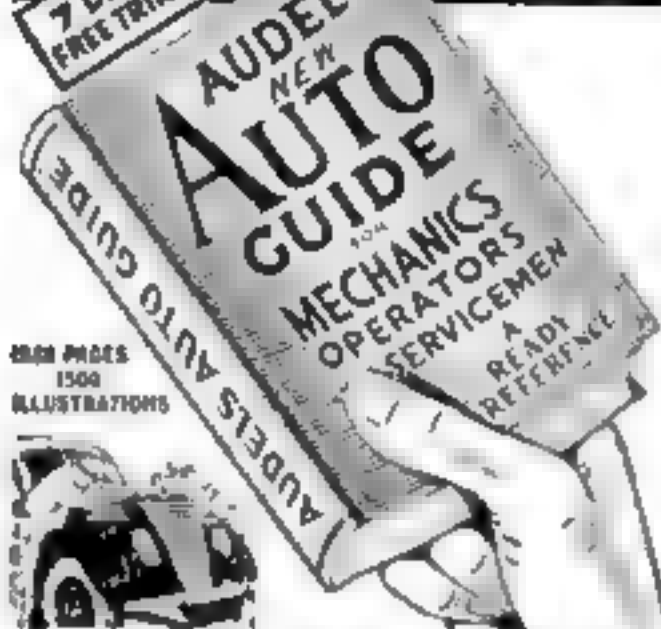
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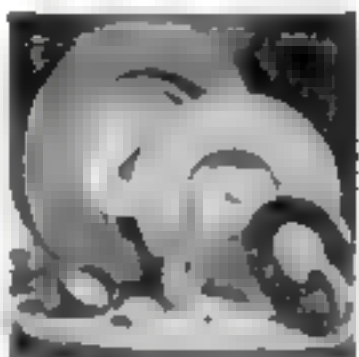
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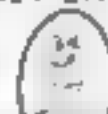
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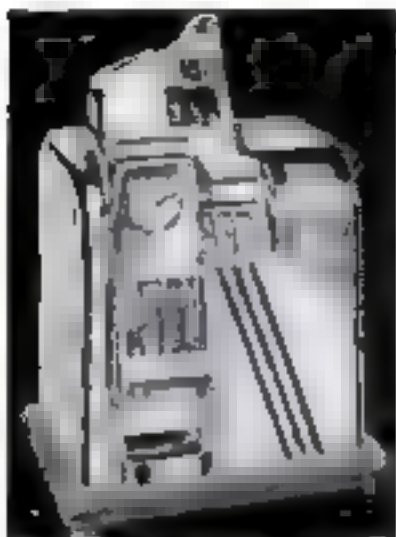


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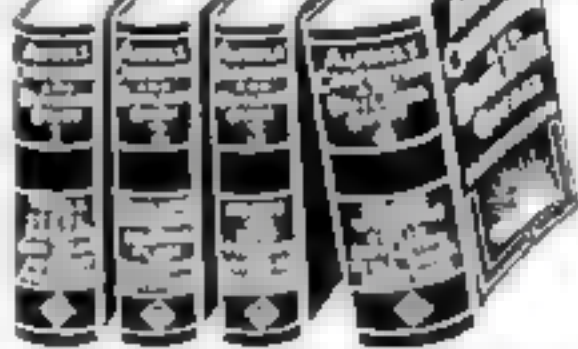
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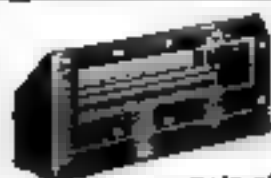
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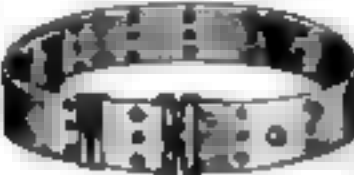
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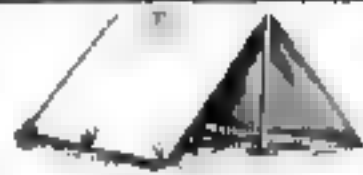


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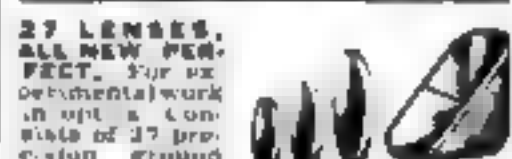
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MONTHLY

**JULY
1946**



Bull's-Eye for an A-Bomb

Painted a blazing red for high visibility, the 30-year-old U. S. S. *Neosho*, which rose from the ruins of Pearl Harbor to fight back at the Japs, waits for the bomb at Bikini.

WIND at Work for

A large, circular, metallic structure, likely a wind tunnel component, with a person standing inside for scale. The structure has a complex internal framework of beams and supports. The lighting is dramatic, with strong highlights and deep shadows, emphasizing the industrial and scientific nature of the scene.

By
DEVON FRANCIS

ON THE coastal flatlands a few miles south of San Francisco the earth begins shaking now and then; to the uninitiated it feels disquietingly like an earthquake. When the dishes rattle, residents of the area know that the world's biggest wind tunnel, two or three miles away, is twisting up air velocities more than twice as high as a mere hurricane. The man-made wind creates vibrations in the foundations and walls of the tunnel. These are felt, oddly enough, only at a considerable distance. In the immediate vicinity of the tunnel the senses resolve the vibrations only as a roar.

The world's biggest tunnel is one of several in the Ames Aeronautical Laboratory of the National Advisory Committee for Aeronautics devoted to research in aircraft performance. One of its sister tunnels makes a rumble that is heard four miles away. Another emits a shrill whistle.

These tunnels, at Moffett Field, Sunny-

vale, California, are eight among a hundred in the United States, and today, for the first time since before the war began, the scientists who run them are able to open their sanctuaries to the eye of the citizen and taxpayer who footed the bill for them. Up to now the national security forbade it.

Strange things have occurred in the six-odd years since the doors of the tunnels were padlocked. Fundamental research in aircraft shapes has abandoned aerodynamics for ballistics. The laboratory winds have reached and gone beyond the speed of sound. The airplane, as yet, has not managed to fly as fast as sound.

In the world's biggest tunnel nine tons of captive air are driven around a squared raceway by 36,000 horsepower. That is the sum of the power in six great motors. Each of the motors would drive a Santa Fe Super

Tomorrow's Planes

This gigantic fan, driven by a 16,000-horsepower motor (low for wind tunnels), hurls gales up to 520 m.p.h. in velocity at airplane parts being tested in a 16-foot wind tunnel at Langley Field, Va. A 16-foot tunnel has a throat or test section 16 feet wide. This one at Langley Field is used in fundamental research by the National Advisory Committee for Aeronautics.

Chief. Yet this tunnel is not a fast one; the air moves at only 250 miles an hour. The tunnel is big to permit research engineers to test full-size airplanes. The throat, or test section where the planes are mounted to be introduced to the blast from the fans, is half again as wide as a city lot and higher than a three-story building (see cover).

Essentially, wind tunnels are only devices for simulating flight under controlled conditions. The aerodynamicists, probing for information as a physician probes for the cause of illness, move air around planes or parts of planes instead of moving the planes through the air.

Tunnels come in all shapes, sizes and characteristics of air flow. Some are tunnels in name only. Some are built solely to obtain a smooth flow of air—one of low turbulence. Some are built for high "Mach numbers." That simply means speed. A tunnel capable of circulating air at a Mach number of .8 has a speed of 608.4 miles an hour, or

8/10ths of the speed of sound in "standard air" (air at a temperature of 59 degrees Fahrenheit at sea level density).

Some tunnels are built for high "Reynolds numbers." That simply means a low disparity between the performance of a model airplane under test and the same thing in full scale.

There are 30 to 40 classifications of tunnels as to specific function. One type, erected vertically, is used to find out how quickly model planes will recover from spins. The controls are "crossed" to produce spins, and at a given moment they are neutralized by clockwork, or by magnetic controls. Movie cameras record the performances. Another type determines the "flutter" characteristics of models, in Freon gas. Flutter is exaggerated vibration. In still another type of tunnel, at an N.A.C.A. installation in Cleveland, the temperature and pressure can be controlled for purposes of hairline accuracy in readings up to a simulated altitude of 38,000 feet. Beyond that the pressure can be dropped to equal 50,000 feet while the temperature is held at -48 degrees F. This tunnel produces 500-mile-an-hour winds.

The speed to be attained in a tunnel largely determines what material it will be made of. Cement-asbestos sheeting suffices in the big Ames tunnel because the air velocities are not high. Little efficiency is lost through friction. But when speeds go to 600 miles an hour or more, welded steel plates are used for both strength and smoothness of surface. A little tunnel producing a 1,500-mile velocity has a throat that is machined as finely as the balance wheel of a watch.

The estimate alone of the power required for a given tunnel is a neat piece of engineering. That depends in part on the mass of air to be moved. The mass in the big Ames tunnel is 24,000,000 cubic feet, or more than three times the capacity of a dirigible the size of the Hindenburg. It also depends on the velocity required, the efficiency of the propellers and motors, and the "losses" in circulation. The losses occur in friction and compression as the air is forced around corners.

Friction is a major problem. If the air flow is extra fast, the tunnel walls have to be refrigerated. In low-velocity tunnels the temperature is kept constant by exhausting part of the stale air in each circuit of the tunnel and bringing in fresh air through an "exchanger". The humidity is controlled by

making the air pass through moisture filters.

In tunnels simulating great altitudes and high speeds, air currents are needed for an added reason. Velocity and low temperature and pressure cause condensation, plain for. Particularly in supersonic tunnels, no dries needed. It has seems the currents intended to record the shock waves forming on a model under test may pick up any condensation waves instead.

Before temperature controls were insti-

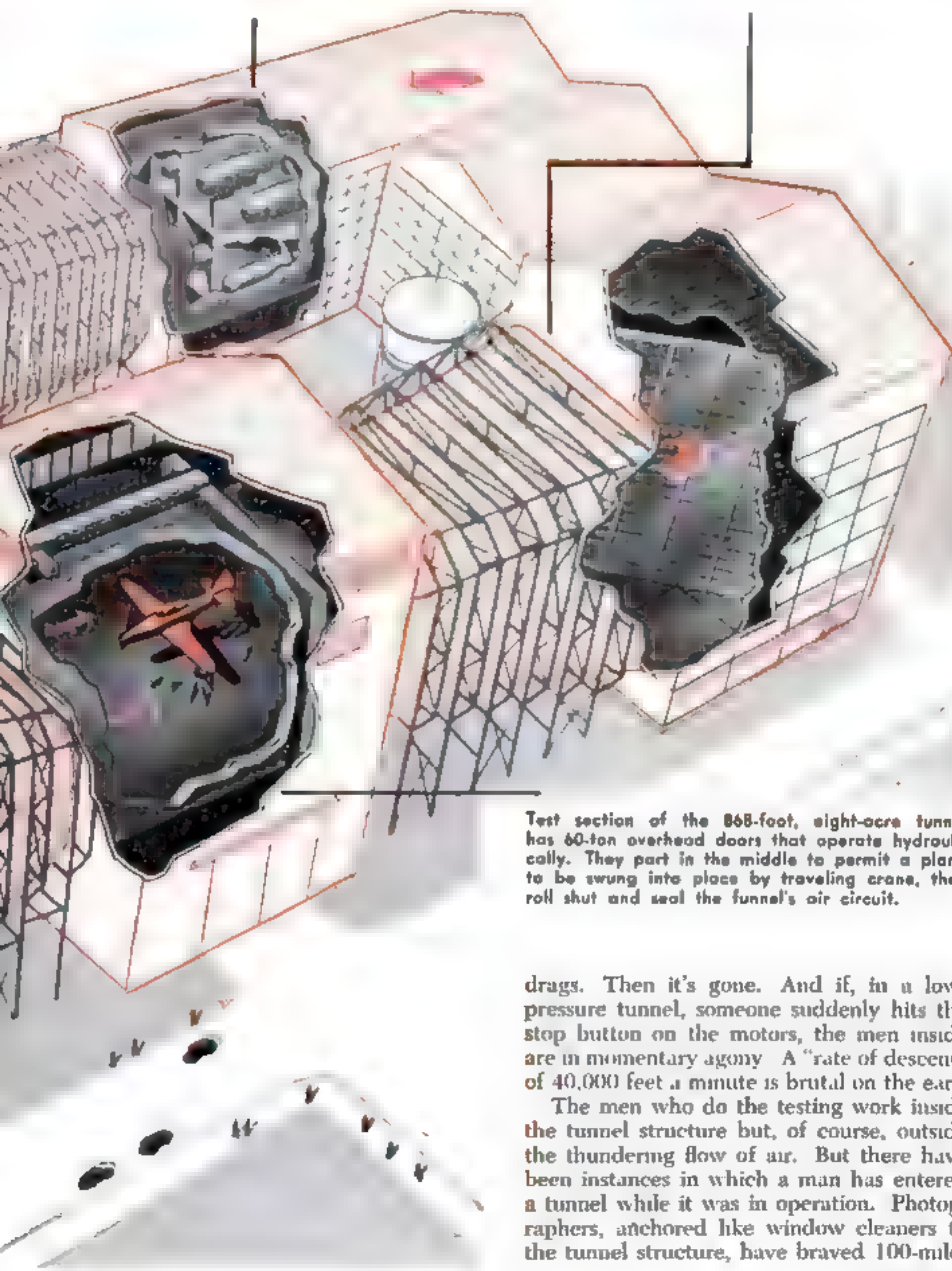
tuted the men working in the tunnels had a rough time of it. The air in one Langley tunnel would shoot from a normal summer 85 degrees to -39 degrees, and workmen larger models had to strip to the waist. The addition of a heat exchanger dropped the temperature to a bearable 105 degrees.

Heat is not the only gas out of. In high pressure tunnels not exact smoke. If they light matches the dense air produces a flame a foot long. A cigarette is good for only two



Six motors, producing 36,000 horsepower, whirl six-bladed, laminated spruce propellers 40 feet in diameter. "Anti-squirrel vanes" are often placed behind them to rob the air of the rotary movement that the propellers give it.

Exit cone, or diffuser, is designed to slow down the air, speeded up by the narrowing tunnel just before it enters the test section. Guide vanes (right of exit cone), of which there are 3,880 in the tunnel, direct air flow around corners.



Test section of the 868-foot, eight-acre tunnel has 60-ton overhead doors that operate hydraulically. They part in the middle to permit a plane to be swung into place by traveling crane, then roll shut and seal the tunnel's air circuit.

drags. Then it's gone. And if, in a low-pressure tunnel, someone suddenly hits the stop button on the motors, the men inside are in momentary agony. A "rate of descent" of 40,000 feet a minute is brutal on the ears.

The men who do the testing work inside the tunnel structure but, of course, outside the thundering flow of air. But there have been instances in which a man has entered a tunnel while it was in operation. Photographers, anchored like window cleaners to the tunnel structure, have braved 100-mile-



Inside the world's largest wind tunnel, at Sunnyvale Calif. Propeller-driven air streams through what appears to be a huge door of corrugated iron but is actually one of several sets of vanes that guide the air around corners of the tunnel. At left Outside view of the entrance cone, or nozzle, which speeds up the air as it enters the test section 80 feet wide and 40 feet high.

an-hour flows to snap realistic pictures.

Dr. Clark Millikan, making some observations in the Cooperative Wind Tunnel at the California Institute of Technology, suddenly was seized by a 150-mile-an-hour wind.

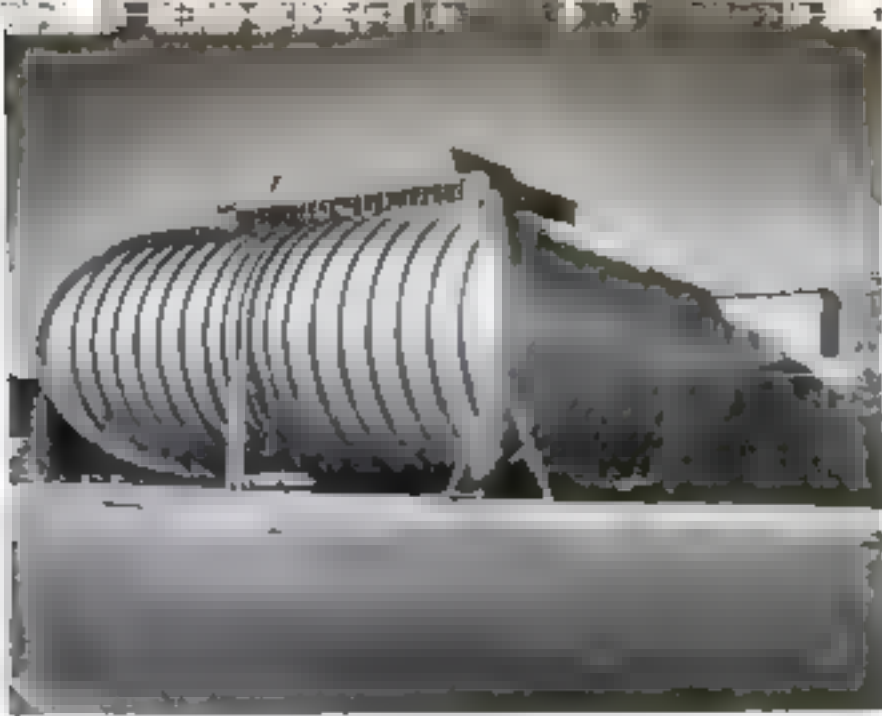
Frantically but futilely grabbing at the smooth, steel slope that led to the throat, he skidded past the big window of the control room. A workman saw him clawing and switched off the fans. Dr. Millikan stopped short of the blades of propellers whirled by four motors aggregating 12,000 horsepower.

With the coming of peace the nation's wind tunnels that were used for applied research for combat superiority are once again being devoted to what they were intended for—fundamental research. This type of research is concerned only with shapes and what they do to the flow of air. Today's Priority Number One project in fundamental research is the production of shapes that will fly at speeds far beyond that of sound. Once a body in flight reaches the speed of sound, it ceases to be a wing and becomes a bullet. That means that a fresh approach

must be made to the science of ballistics.

The men who make tunnels got ahead of the men who make airplanes in the field of speed by filching some secrets from nature and by impudently circumventing nature. They discovered, for instance, how to *simulate* speeds above that of sound. The speed of sound always was a ghostly barrier athwart the path of engineers seeking velocities of thousands of miles an hour. That was because shock waves formed. The air piled up. Constipation set in.

The tunnel men put models in a compressed helium-gas gun and shot them into a tank containing Freon gas. The speed at which they could be shot depended on the speed with which the gas would flow out of a pressure chamber, through a tube and into the tank. This speed was limited in turn by the speed of sound in helium—about 1,380 miles an hour. Helium would flow through the tube faster than air, hence its use. Under 200-pounds-per-square-inch pressure, the helium catapulted the models into a gas where the speed of sound was only 340



Most wind tunnels are rectangular instead of circular, as this one at Langley Field makes clear, to avoid the problem of constructing compound curves. The power they require goes up as the cube of the speed and can become a critical problem. A wind tunnel operated by Boeing at Seattle can be run only during the early hours of morning because of the drain it imposes on the city's power supply.

Looking (upper right) into the converging test section of the N.A.C.A.'s eight-foot tunnel at Langley Field. This tunnel has provided more information about velocities ranging from 680 to 840 miles an hour—the transsonic area—than any other in U. S. The Germans were woefully short of such data.

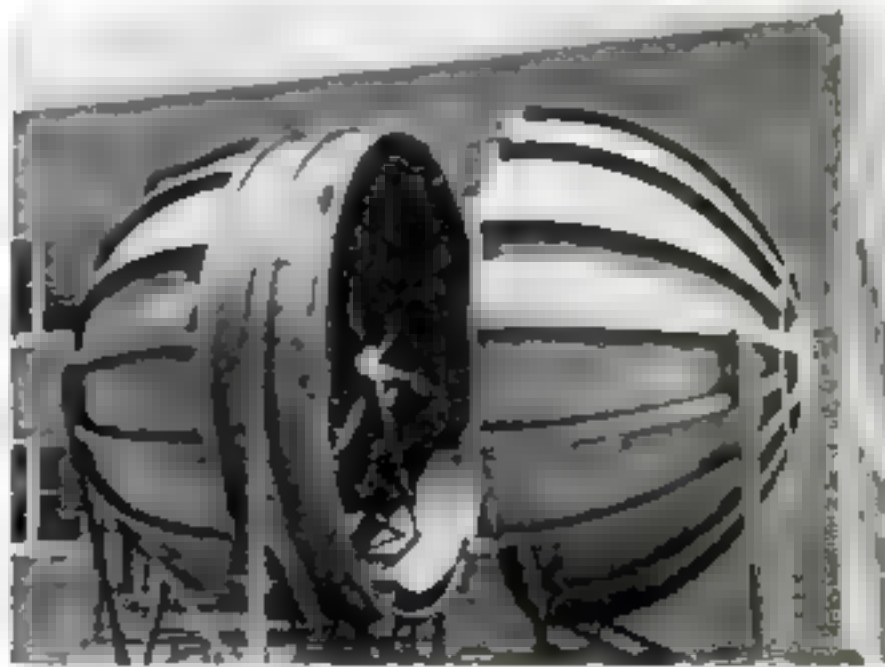
Observers (below left) evaluate pressures exerted on every square inch of a structure under test in a wind tunnel and movie cameras take progressive records of pressure readings. In most tunnels mechanical or electronic scales measure the lift and drag forces exerted on wing and tail surfaces.

When the split sphere below at right is put together and filled with Freon gas, it becomes a wind tunnel in which propellers and airplane structures are whirled to determine their reaction to air flow at transsonic speeds. In another uncommon tunnel, model planes are launched in free flight, their controls moved electronically.

miles an hour. Thus a simulated speed of about 3,000 miles an hour was reached.

The engineers did create actual wind velocities of twice the speed of sound. When the velocity of the air just about reached the speed of sound and the air itself was jamming up in a constricted section of the tunnel, they suddenly gave it space to expand in. That boosted the velocity twice. The law that the engineers took advantage of was Bernoulli's. In a streamline flow, the greater the speed of the air, the less the pressure.

While the tunnel engineers have achieved such speeds, they are still stumped by some of the problems posed at an intermediate point—the speed of sound. They can make air go at 760.5 miles an hour, but it is hard to get information from the flow. Until recently the transsonic area, from approximately 680 to 840 miles an hour, was a complete blind spot. It was hard to obtain flow readings in this range because of interference waves. A shock wave produced by a model would hit the sides of the tunnel and bounce back on the model or on itself. Only when the air passed into the supersonic range did the interference waves occur behind, instead of on or near, the model.





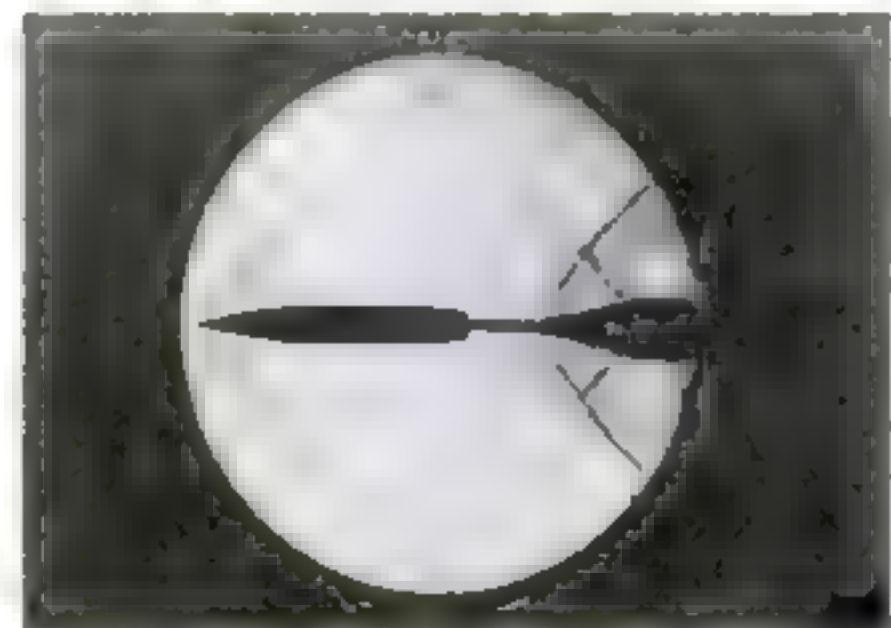
This Freon-filled tube enables researchers to find out how projectiles act at simulated speeds three times that of sound. Through windows, electrically tripped cameras photograph the projectile's path.



Tomorrow's supersonic plane may look like this. Bell Aircraft Corp. put the swept-back wing on one of its fighters to determine how "shock wave effect" at very high speeds might be postponed.



Biggest little tunnel in U. S. produces 1,500-m.p.h. winds. Protruding bolt heads show how interior has been constricted to speed the flow of air; later it is suddenly expanded to gain even higher velocity.



This photograph, made by spark exposure at four-millionths of a second, shows the shock wave on a pointed shape in a 1,140-m.p.h. wind. Shock waves to the rear are formed by the pointed shape's support.

The Germans apparently did not know what U. S. scientists now know about transsonics. They know that at sonic speed the "stick forces" in a cockpit reverse themselves. They know in general what tomorrow's supersonic wing will look like. It will have a sharp, instead of bulbous, leading edge, like an armor-penetrating bullet. It may be swept back radically like the paper airplanes boys fly in the schoolroom. Or it may be swept forward. It will generate some 400 degrees of heat by friction at 1,500 miles an hour and 1,120 degrees at 2,500 miles an hour.

Much of that information came out of one of Langley's high-speed tunnels with an eight-foot throat. Engineers contrived to get interference-free readings out of so big a tunnel at sonic speeds by boosting the motor power, running the tunnel up to the "choking" point and then jamming the air

on through until the shock condition was beyond the test section.

That U. S. wind tunnels have solved perhaps the most pressing of the problems of transsonic and supersonic speeds is indicated by the tacit admission that an airplane "capable" of supersonic flight will be constructed and flown before the year's end.

Higher tunnel speeds are coming. To the rowdy, noisy 1,500-mile-an-hour tunnel at Ames will be added this month a sister tunnel to produce velocities above 2,600 miles an hour. It will be still noisier, so noisy that it will have to be fitted with a muffler. This tunnel will represent as much research in tunnel design as it will in supersonic flight shapes.

That may be only a beginning. The tunnel men, their ghostly barrier behind them, are talking glibly of producing winds of 7,000 miles an hour.





John V. L. Hogan, one of the pioneers of facsimile, points to a picture transmitter. The equipment at his back, topped by the cylinder, is the scanner.

Home reception of a radio newspaper. The receiver can either be built into a radio or used as a separate unit. It is about as large as a phonograph.

Printing by Radio

Broadcasters are ready and suitable receivers may be available this year.

ATTER more than 10 years in the laboratory, facsimile broadcasting is getting ready to make its public debut. The printing of text and pictures by radio is widely expected to be one of the industry's most significant developments.

Because of the speed with which facsimile can print late news reports in your home, many people think it will make newspapers obsolete. Much of the experimental work, however, has been conducted by newspaper-owned radio stations who see radio printing as an extension rather than a replacement. The pictures on this page illustrate two of the recently announced systems.

A page to be broadcast is placed on a revolving cylinder and scanned by an electric eye. The optical system responds by translating the varying degrees of light intensity into electrical impulses. At the recording end, these impulses activate a sheet of sensitized paper, turning it black in the same degree as the picture signal being received.

Comfortably readable print can be transmitted at about 500 words a minute, or four times as fast as the spoken word. With a timing device, your morning paper can be printed at home while you sleep.



On a pilot boat in Ambrose Channel, New York Harbor, the captain sends a facsimile message to Western Union announcing the arrival of a steamship. It's part of W.U.'s marine news service.

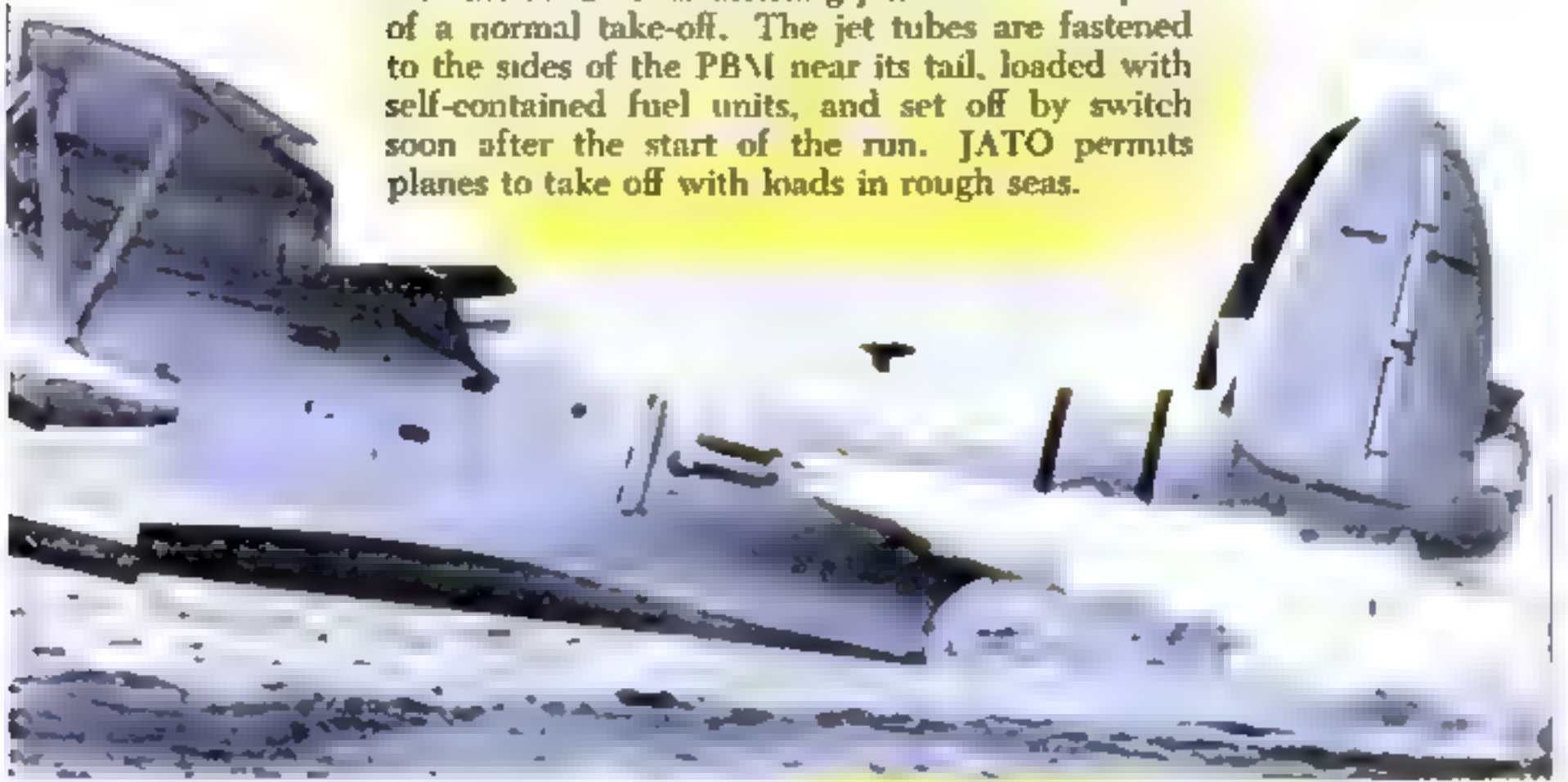


Birth of JATO. American scientists early in the war learned how to make planes leap from the ground in jet-assisted take-offs (JATO). In August 1941 an Ercoupe (left), assisted by six small rocket motors developed by California Institute of Technology, sprang off March Field in 7.5 seconds after a run of only 300 feet. The motors burned a dry propellant, an amide powder, each delivering a 28-pound thrust for 12 seconds.

Another trail-blazing JATO flight took place in April 1942, when an A-20A bomber (below) with two liquid jets burning aniline lifted its seven tons from a Muroc, Calif., field in record time. Its jets were fed fuel under pressure from nitrogen in the forward bomb bay, delivered 2,000-lb. thrust for 25 seconds.



Kicking Off a PBM. A lumbering patrol bomber of the U. S. Coast Guard here is booted into the air by four assisting jets in half the space of a normal take-off. The jet tubes are fastened to the sides of the PBM near its tail, loaded with self-contained fuel units, and set off by switch soon after the start of the run. JATO permits planes to take off with loads in rough seas.



Rocket Boosts Racer. Using a rocket for the first time to shove a racing car, Duke Nalon, Beverly Hills, Calif., driver, reported that he gained from 30 to 40 miles an hour along the backstretch of the Indianapolis Motor Speedway during a trial run (below). Nalon's racer mounted a 40-pound rocket (left), which gave him a four-second boost to an estimated 140 m.p.h.

Rocket- or jet-powered cars were not eligible to enter the Memorial Day race at Indianapolis. The smoke trail Nalon's rocket left made it obvious that such a car would be a hazard on the track. Tests of his racer were preliminary to experiments to determine if rockets can be used as auxiliary brakes on trains.



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The Winners! GI Handicraft Contest

PRIZE-WINNING ENTRIES in *Popular Science Monthly's* GI Handicraft Contest were selected last month by a committee of distinguished judges, including Frances Lang-

ford, Maj. Gen. Alden H. Waitt, Rear Adm Harold B. Miller, Mrs. Cass Canfield, Nathaniel Saltonstall, Merle D. Miller, and Walter W. Hitesman, Jr.

TELEGRAMS OF CONGRATULATIONS SIMILAR TO THE ONE ABOVE WENT TO:


Second Prize (\$500) winner: Lt. John Veltman, 85 Greenwood Pl., Valley Stream, N.Y.
Third Prize (\$200) winner: Ray MacDonald, Jr., 1237 Cameron Ave., Plainfield, N. J.
Fourth Prize (\$125) winner: Lt. L. A. Nelson, USNR, 810 7th Ave., San Francisco, Cal.

Fifth Prize (\$100) winner: Pfc. Frank Willie, 18 Colonial Ave., Haddonfield, N. J.
Sixth Prize (\$75) winner: Sonny Cross, 1323 E. Kirby, Detroit, Mich.
Seventh Prize (\$50) winner: Earl G. Becker, Route 1, Moxee City, Wash.

FIFTY AWARDS OF \$25 EACH WENT TO THE FOLLOWING.

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Joe Gianne, 1415 Astoria Blvd., Astoria, L. I.
Ottavio Guidi, 6010 Magnolia Ave., Philadelphia, Pa.
George J. Hartman, 2045 N. 32 St., Milwaukee, Wis.
Sgt. George Haynes, Jr., 2704 Campbell St., Houston, Tex.
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M. B. Kellher, 343 Dayman St., Long Beach, Calif.
John Kuchta, 68 William St., Dover, N. J.
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E. L. Snyder, 10 Pelican Ave., Audubon Park, N. J.
Thomas Schultz, Neffs, Ohio.
Frances E. Shaffer, 606 Arden Ave., Annandale, N. Y.
Edward Simon, 839 Brady Ave., Bronx, N. Y.
R. J. Simonson, 223 4th St., Stambaugh, Mich.
ARM 1/c Francis Slizy, NAS, Lakehurst, N. J.
August Ulahos, 2155 W. Superior St., Chicago, Ill.
Angelo Urso, 34 Hart St., Brooklyn, N. Y.
George Vanetsanos, 610 Vanderbilt Ave., Brooklyn, N. Y.
Pfc. Walter N. Wrber, 204 E. 1st St., Streator, Ill.
T/S Harold B. Whiting, 610 W. 4th St., Plainfield, N. J.
A. E. Willis, 335 E. 56th St., New York, N. Y.
Frank H. Wright, 301 Audrick St., Fort Scott, Kan.
Thomas J. Wyse, 103 Eads St., Pittsburgh, Pa.



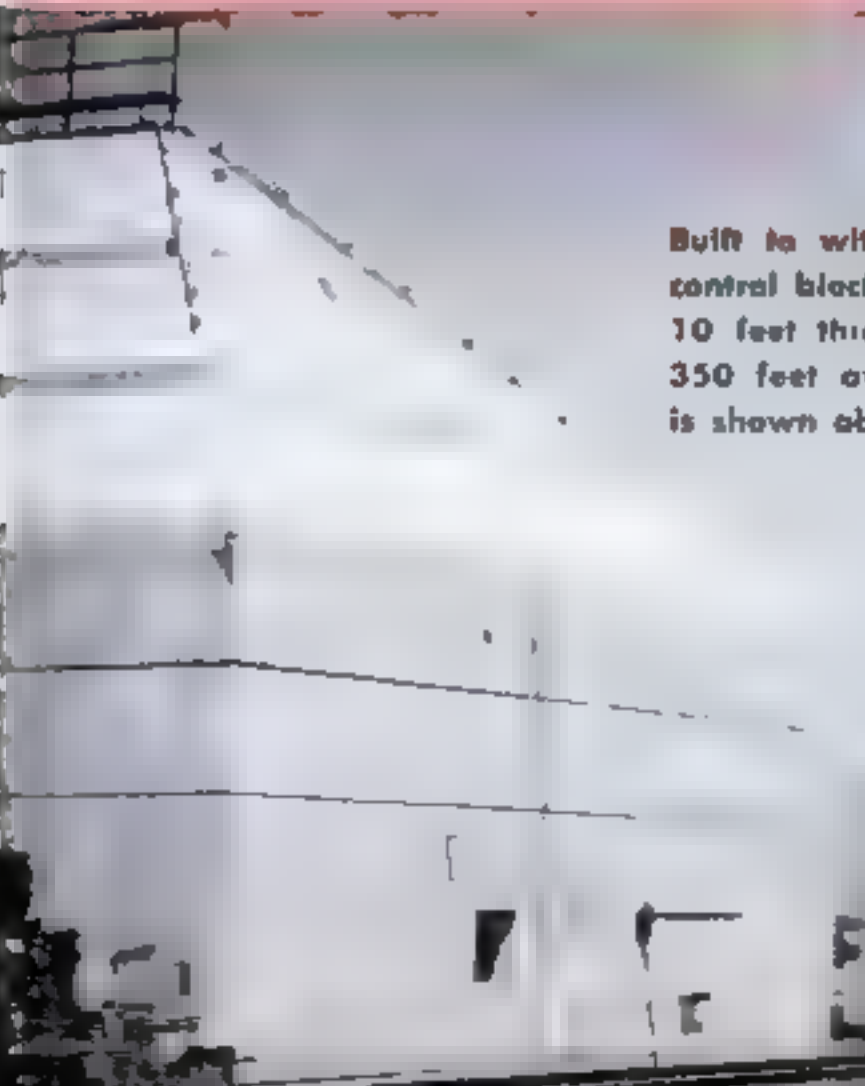
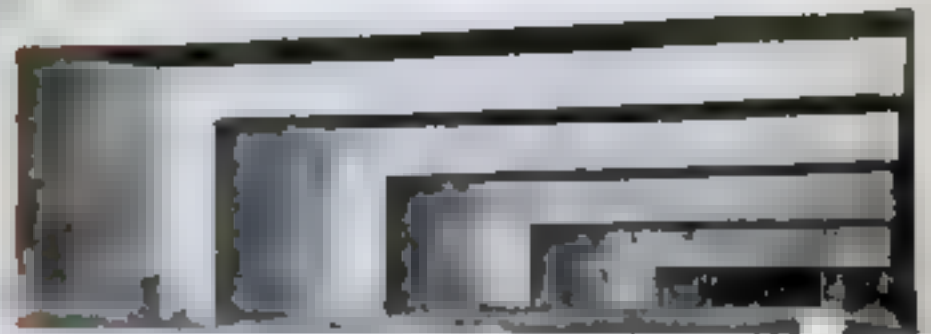
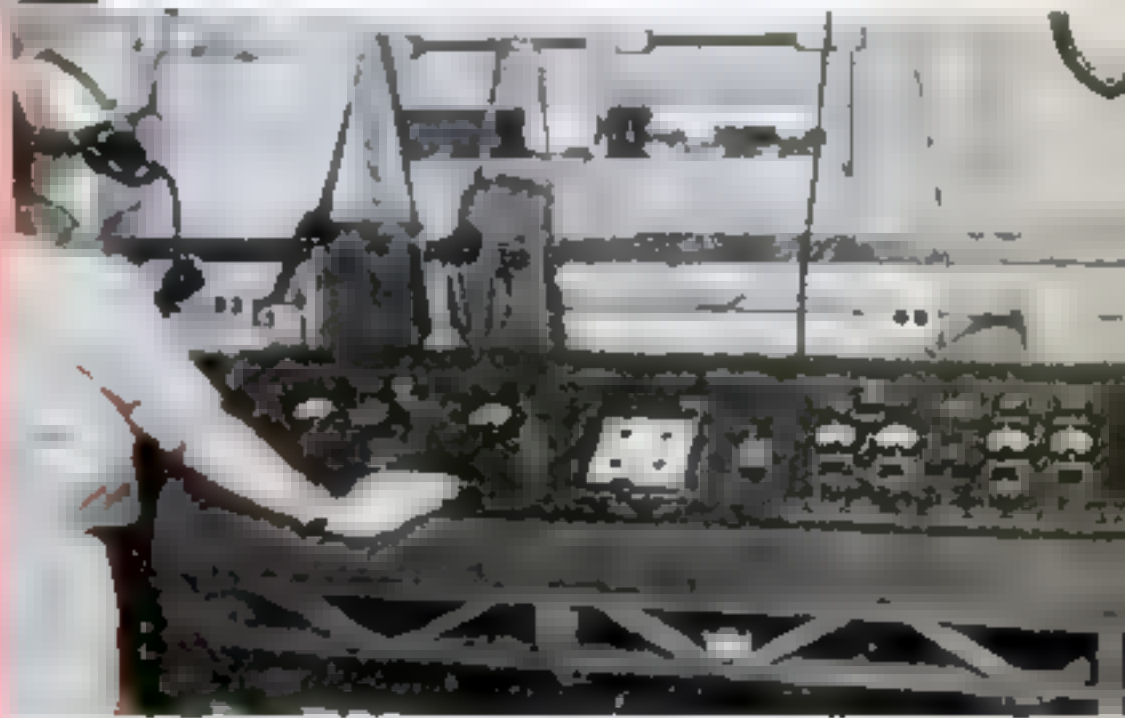
Firing V-2s *into* No Man's Air

All photographs taken at White Sands, N. Mex.,
by PSM Staff Photographer Hubert Lockett

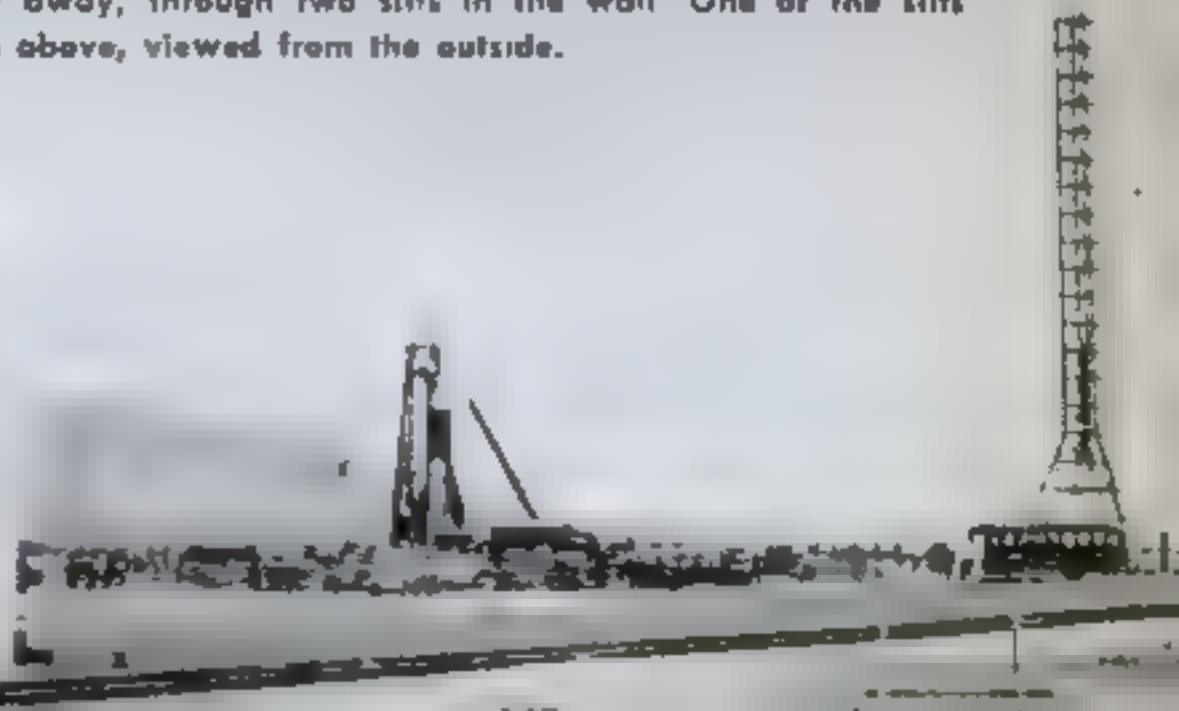
Weekly trips to higher altitudes than men have ever ascended are being made now by German V-2s from the Army's White Sands Proving Ground in New Mexico. The 46-foot, 26,000-pound rockets are being fired to bring America's knowledge of long-range, guided, flaming arrows up to date and to answer the physicists' questions about the unexplored outer fringes of the earth's atmosphere.


Controls for the V-2s (right) and for the U.S.-developed "Wac Corporal" (above), another type of rocket are arranged on panels in a blockhouse of steel-reinforced concrete (below).

The V-2 operator (right) has two-way telephone and radio contact with the ground crew and outlying observation posts. After the ground crew has retired to safety he checks the rocket's mechanism by meters and indicators still connected to it by electric wires. From this panel he sets off the pyrotechnic pinwheel that ignites the V-2's fuel. He lets the fuel burn briefly at a reduced rate while he checks the motor's performance, then releases the missile.



Built to withstand a direct hit in case a rocket goes wild, the control blockhouse's pyramidal roof is 27 feet thick and its walls 10 feet thick. Observers inside keep an eye on the firing area, 350 feet away, through two slits in the wall. One of the slits is shown above, viewed from the outside.






Electric cables leading into the V-2 (left) furnish power to bring its gyros up to speed before launching. They also carry the wires that connect vital controls to the panel in the blockhouse. Cables are dropped after the rocket's fuel starts burning but before the full blast of the motors is turned on.

Towerlike device at V-2's left is ingenious Meißler Wagon, which hauls the rocket to its site and lifts it into place hydraulically.



Gyroscopes that act like an automatic pilot to keep the V-2 on a steady course can be set in advance to tilt it at a predetermined height, so that it will follow the desired trajectory. They are reached through removable inspection plates (above). The control system functions by means of air rudders on the main fins and two pairs of graphite rudders set in the jet stream. It is entirely self-contained and preset, except for fuel shut-off, done by radio from the ground.



Loading 16,000 pounds of fuel into a V-2 (left), which weighs 10,000 pounds empty. This is enough fuel for about 65 seconds of powered flight. The tank trailer contains alcohol. Other components of the combustible mixture are liquid oxygen, hydrogen peroxide, and a permanganate catalyst.

A take-off (below), photographed through a telescopic lens by PSM's Hubert Luckett, who with other press observers was not allowed to stand closer than 1,000 feet away.

"It seemed to float into the air almost like a balloon," reported Luckett.

Actually the V-2 gains speed at the rate of 32 feet a second for each second of flight; that is, it travels 16 feet the first second, 48 feet the next, and so on.

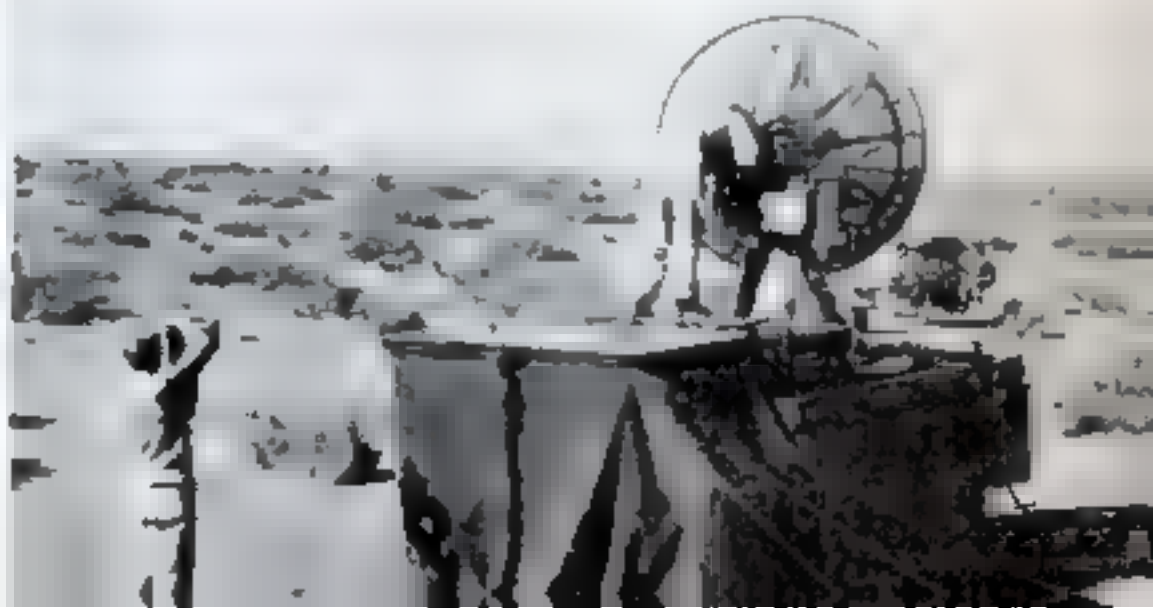


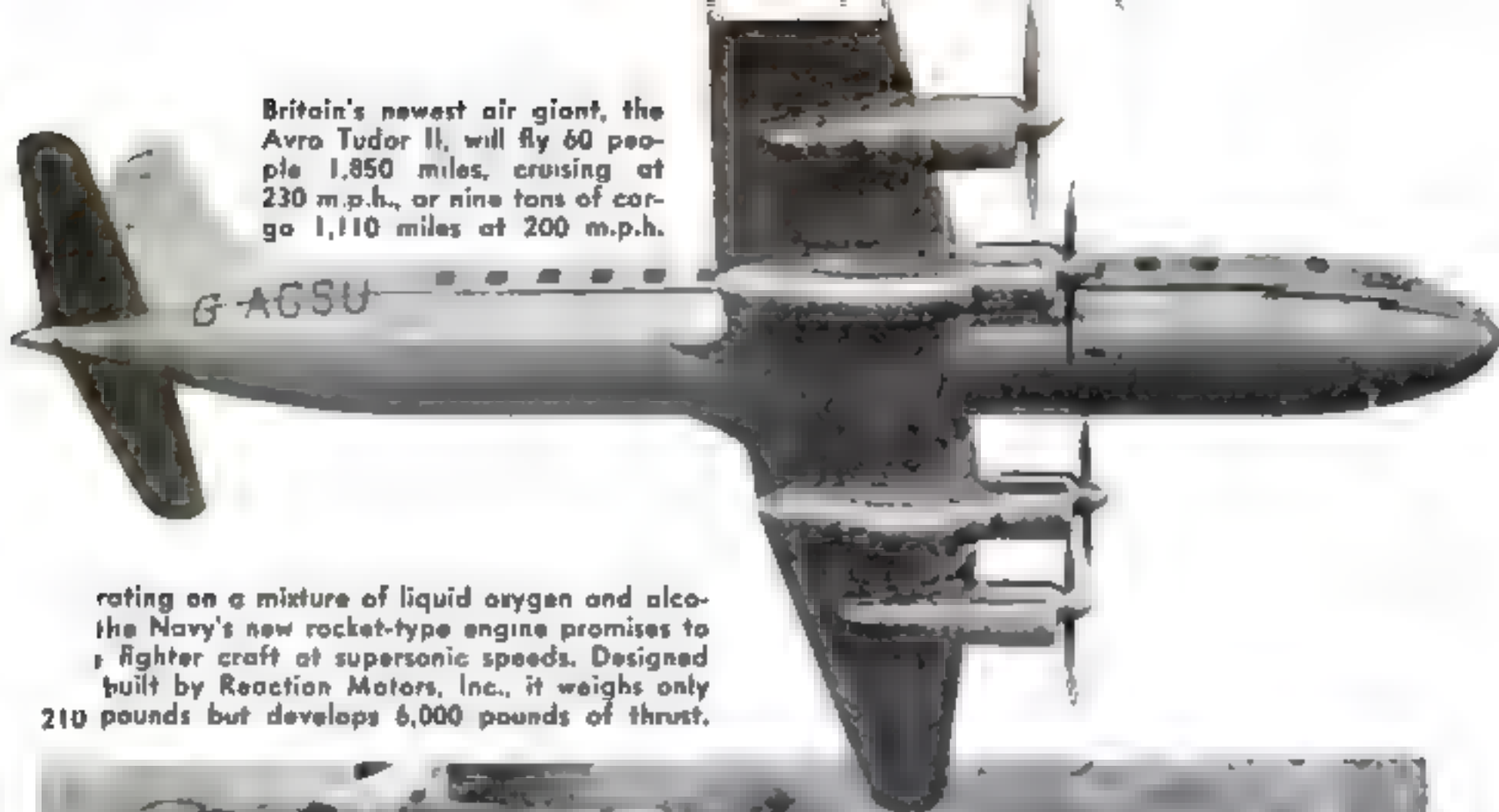
Three seconds after take-off the V-2 is in full flight (above). Its maximum speed is 5,600 feet per second, or 3,800 miles an hour. The fact that its two black fins are visible instead of the two yellow ones shows that the controls are functioning properly and that the rocket has not rotated since it left the ground. This is a pretty sure indication that the flight will be successful.



V-2's vapor trail in cold outer atmosphere is twisted by winds. The rocket is going straight.

A small radio transmitter in the rocket that sends out a signal when triggered by radar pulses from the ground enabled radar operators (below) to track the second V-2 fired to height of 75 miles.



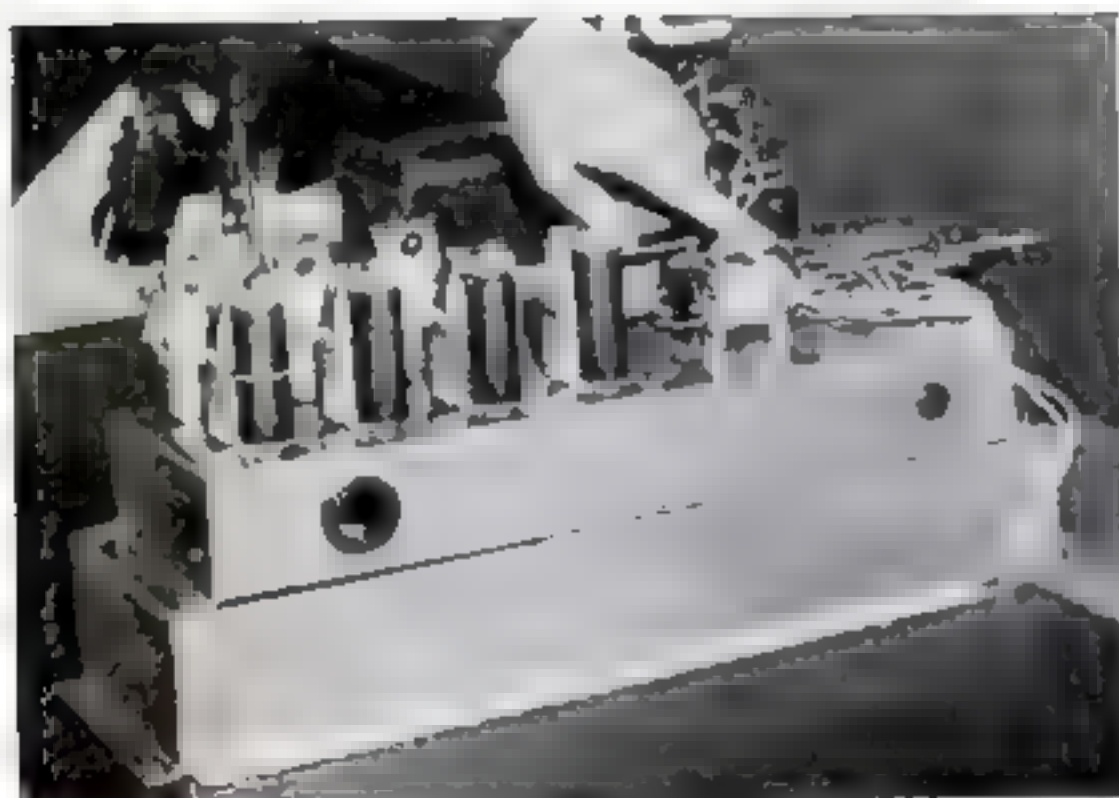


Britain's newest air giant, the Avro Tudor II, will fly 60 people 1,850 miles, cruising at 230 m.p.h., or nine tons of cargo 1,110 miles at 200 m.p.h.

rating on a mixture of liquid oxygen and alcohol. The Navy's new rocket-type engine promises to power fighter craft at supersonic speeds. Designed and built by Reaction Motors, Inc., it weighs only 210 pounds but develops 6,000 pounds of thrust.



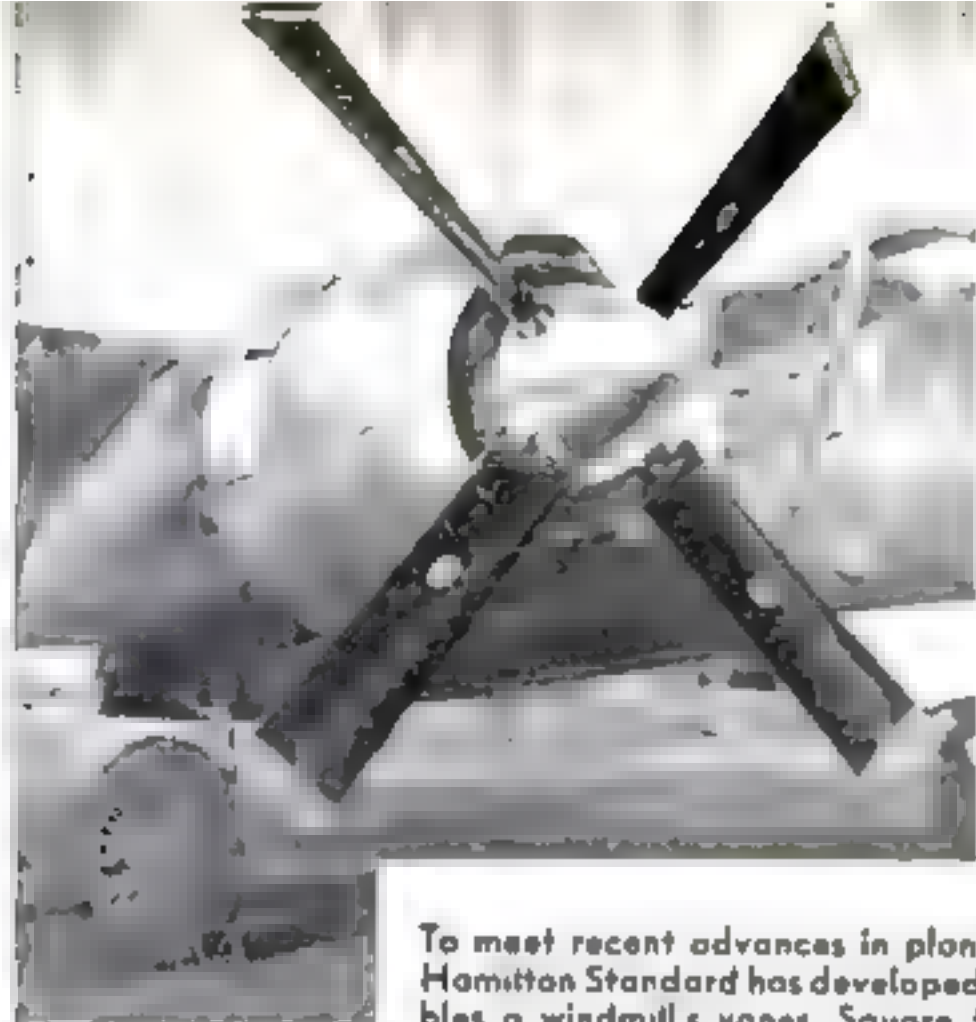
WHAT'S NEW in AVIATION



In "push-button" flying, developed by AAF engineers, an electronically guided plane takes off, flies to a selected point and lands. Key element of the system is the Master Sequence Selector (left) of the Automatic Flight Controller.

By using lightweight nylon fuel cells (right), a Boeing Stratocruiser can carry seven extra persons on a 4,200-mile nonstop flight. Empty, cells pack into tight rolls.

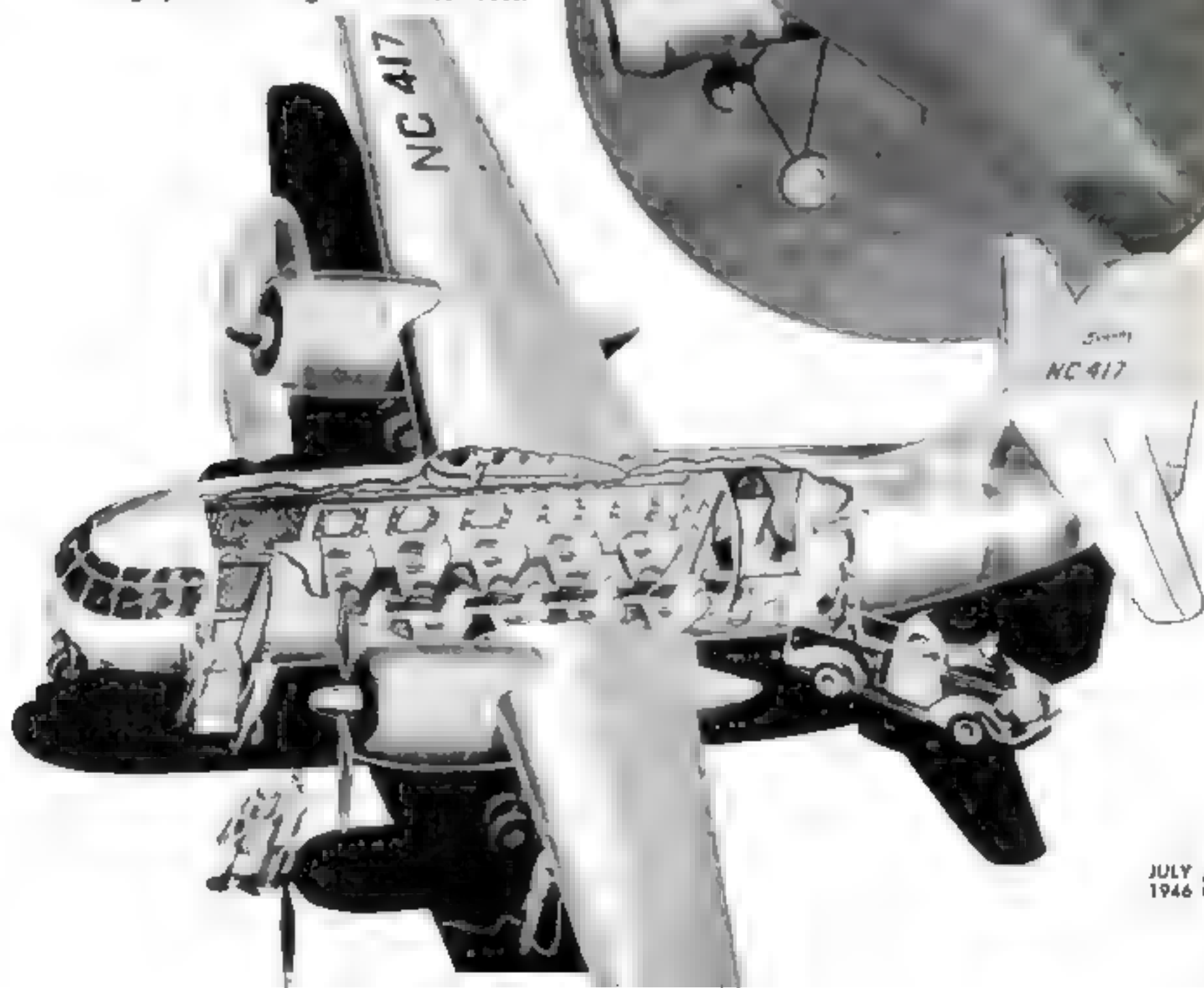
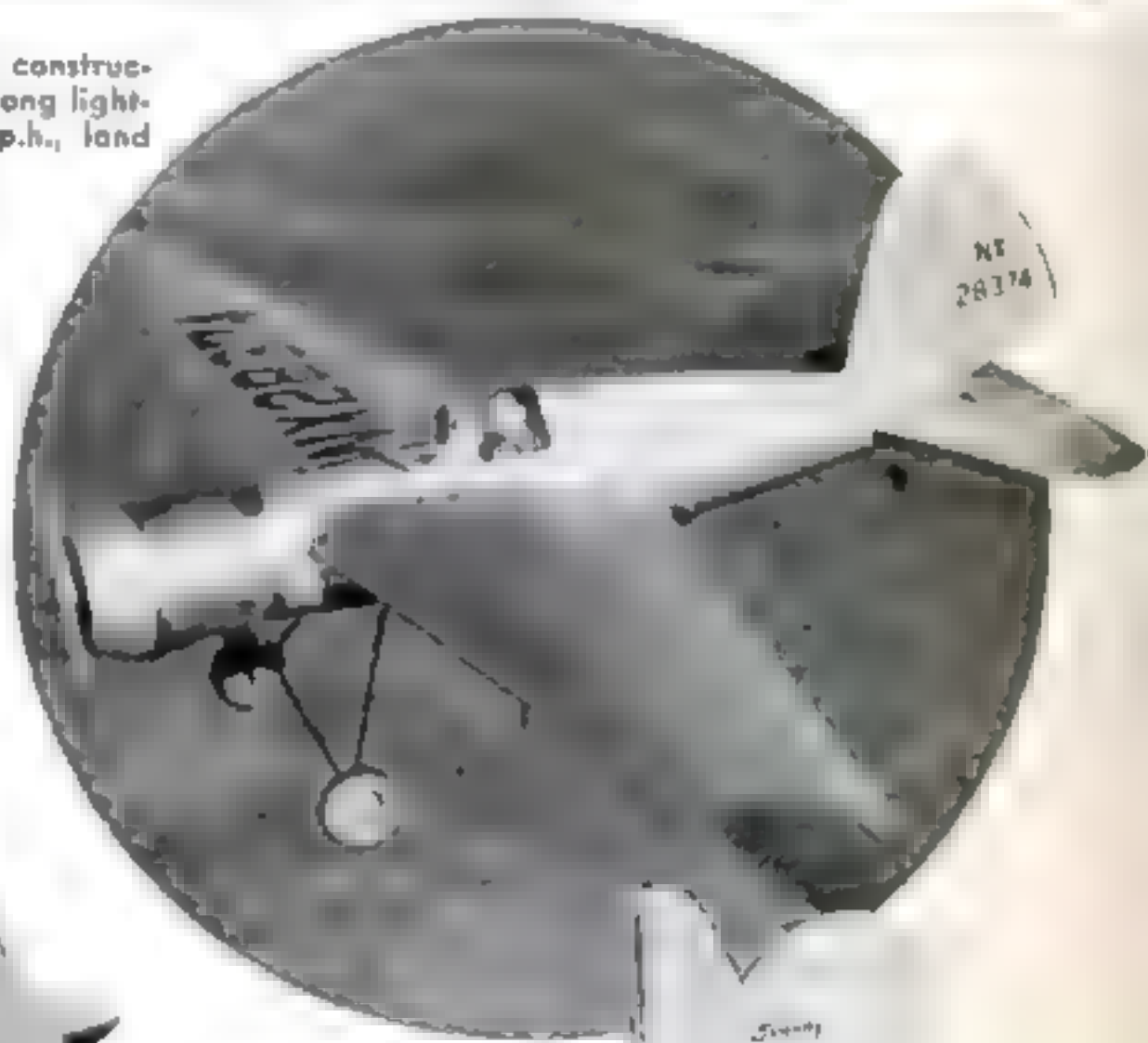




To meet recent advances in planes' speed and engine power, Hamilton Standard has developed a propeller blade that resembles a windmill's vanes. Square tips boost power absorption.

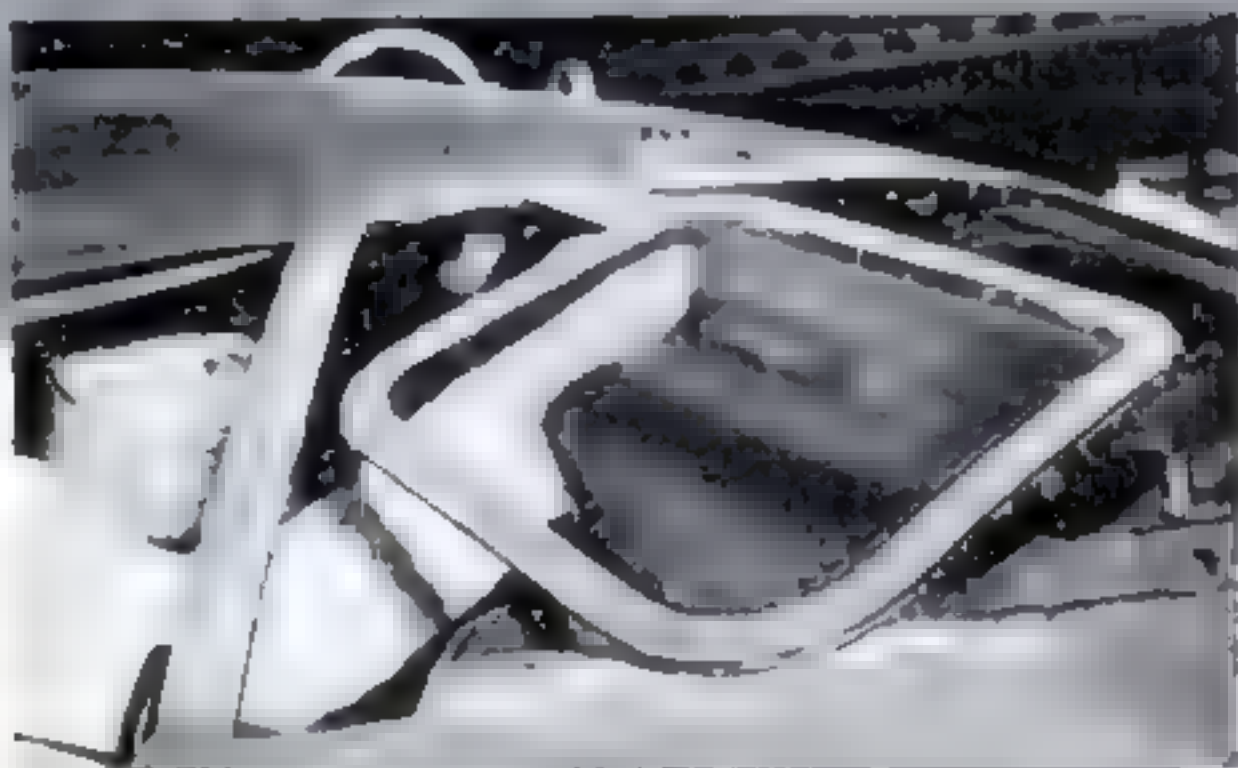
The Thalmon Special (right) has geodetic construction (basket weave of the ribs), unique among light-planes. Maker claims it will go 150 m.p.h., land at 35 m.p.h. with flaps, climb 1,000 feet a minute, withstand exceptional stresses, and cruise 900 miles.

The Boeing 417 (below), little brother of the Stratocruiser, will seat 20 to 24 passengers. Designed for local service and feeder air lines, it will be powered by two 800-hp. Wright Cyclone engines and will utilize a thermal anti-icing system on wings and tail surfaces.





The "Holey Crow," a specially heated Curtiss C-46 whose fuselage has been punctured frequently by bullets of ice, is a flying laboratory for a study of icing and ways to offset it. Odd object on top of the plane is an electrically heated airfoil model used in icing tests that the National Advisory Committee for Aeronautics, Ames Laboratory, and United Air Lines are making.



Ice formations as heavy as those on the pitot tube and loop antenna housing below can cause errors in airspeed and attitude indications.



Electrically heated windshield in test plane helps determine how much warmth is needed to dispel ice without distorting vision. Heat from exhaust gases is piped to leading edges of wings and tail surfaces.

"Glove" (right) focuses exhaust-heated air on leading edge of C-46's wing. Lower left: Gun-camera installation used to photograph test plane's heated windshield.



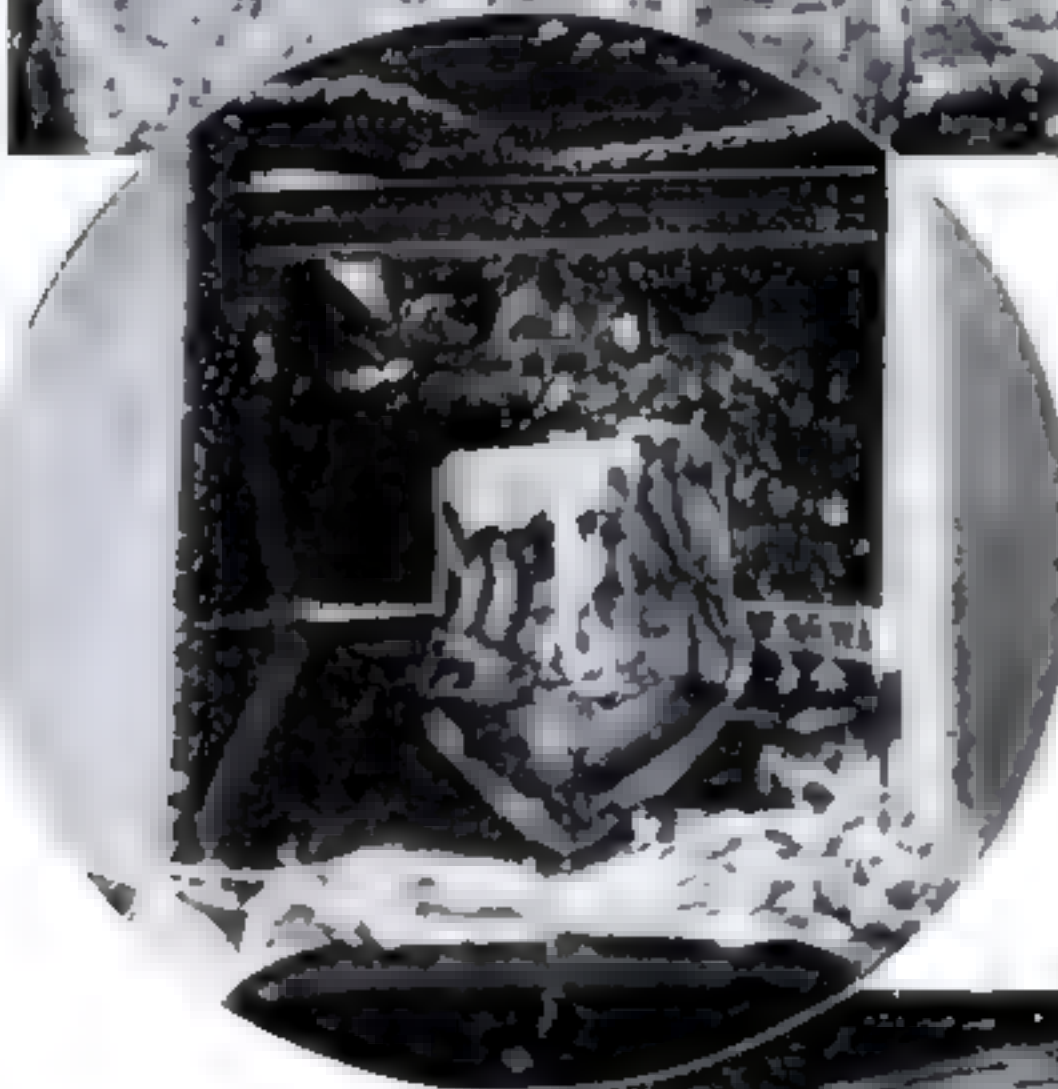
First U. S. jet-propelled bomber, the Douglas XB-43, is expected to exceed 500 m.p.h. Its two T.G. 180 engines, mounted in line within fuselage, supply 8,000 pounds of static thrust. It has pressurized cabin for high altitudes and a service range of over 1,400 miles.



Paul Bunyan Scissors



Mythical Paul Bunyan, superlumberman of the Northwest, could hardly have outdone the performance of the Mammoth Tree Shears illustrated here. Mounted on a track-type tractor, the shears can snip off a tree up to 30 inches in diameter in about a second. In the above picture, the machine has advanced head-on and, with the 60-ton pressure of its alloy-steel shearing blades, lopped off a good-sized tree at its base. An experienced operator can toss the trunk to the right or left merely by manipulating the steering controls.



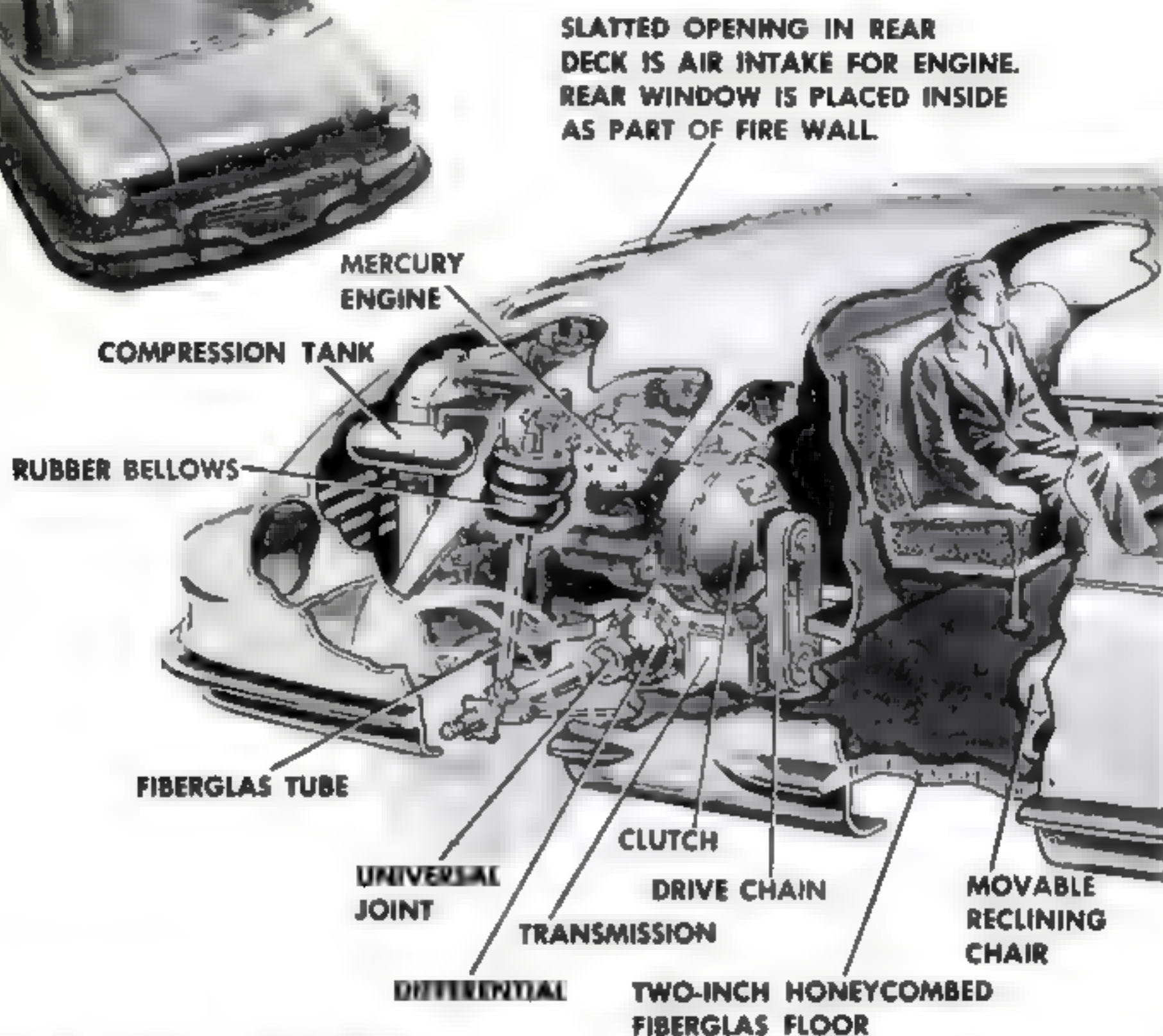
Close-up view of the snipper doing a job, with the chips falling where they may. The man at the controls may lower or raise the shears to cut the tree either flush with the ground or to leave a stump up to two feet high. The tractor then passes over the stump and on to the next tree marked for similar felling.

The 16-inch-wide stump of a tree cut flush with the ground. The tractor-powered shears used were invented by Kirk Knight, a Texas farm boy, who got his idea from the use of tin shears. H. L. Collins, a San Antonio engineer, redesigned the machine to increase its efficiency.





"Stout Forty-Six" as it looks on the streets of Detroit. Its body is wider than that of standard cars. Notice how the windshield posts are moved back to provide wide, unobstructed driver vision.



GLASS CAR Needs no Frame

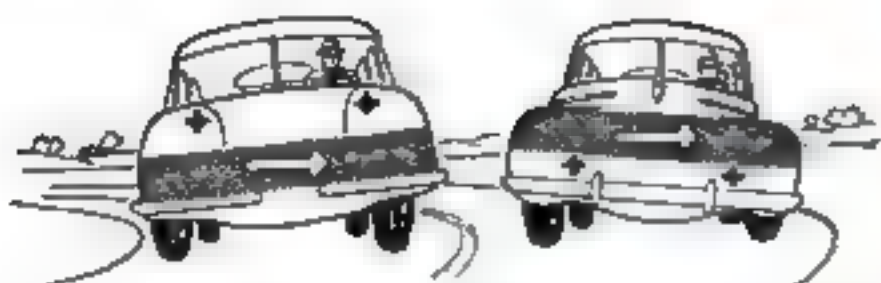
THE plastic car, once the favorite drawing-board dream of wartime designers, is here—but there is only one. William B. Stout, veteran airplane and automobile designer, owns it. Built according to his blueprints, the "Stout Forty-Six" has a body made of Fiberglas plastic, and a string of other unconventional features—no frame, engine in the rear, air-cushion springs, and doors that are opened with electric push-buttons.

Laminated Fiberglas used in the body has been estimated to have, pound for pound, five times the strength of structural steel and three to four times the impact strength.

You can smash the rear deck with a sledge and not make a dent. This strength allows the body to be used as a structural part, like some airplane fuselages. Springs and engine are hung from thickened portions of the body.

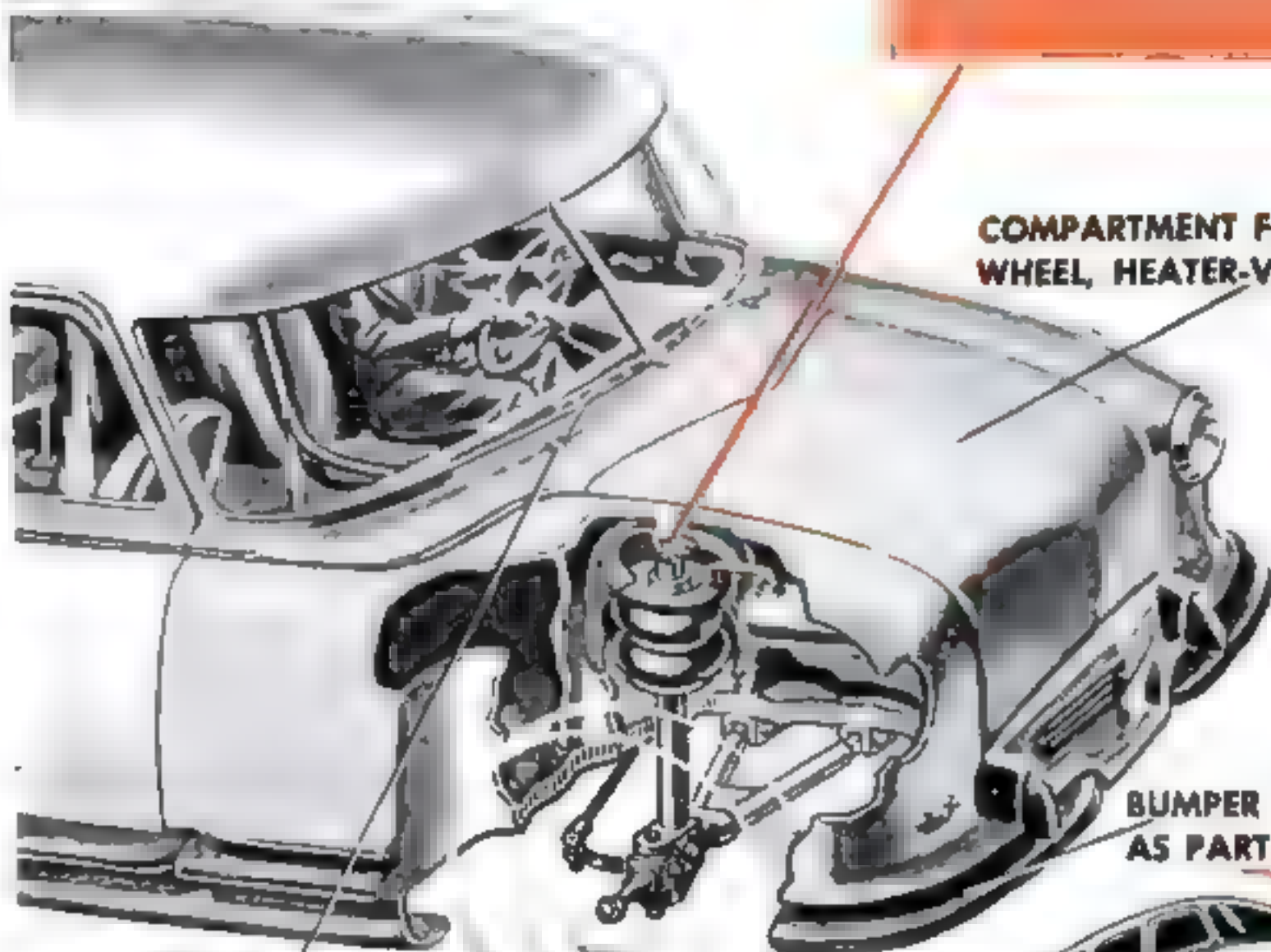
Floor, roof, sides and ends are all molded in one piece from layers of glass-fiber cloth, soaked with plastic, then heated. Varying thicknesses of the glass cloth are used, from 1/16 inch (three plies) to 1/2 inch (20 plies) to the two-inch floor formed by sandwiching honeycombed sections between two sheets of Fiberglas plastic.

Stout kept one eye on the scale when he



Centrifugal force banks the Stout car (left) around turns, airplane fashion, while standard car leans toward outside of curves. Xs mark suspension points.

Landing gear type of suspension is used. Front wheels hang from hinges at top of body 40 inches off the ground. V shaped arms help to support them.



COMPARTMENT FOR SPARE WHEEL, HEATER-VENTILATOR, LUGGAGE

BUMPER MOLDED AS PART OF BODY

WIPER BLADE FOLLOWS CURVE OF WINDSHIELD

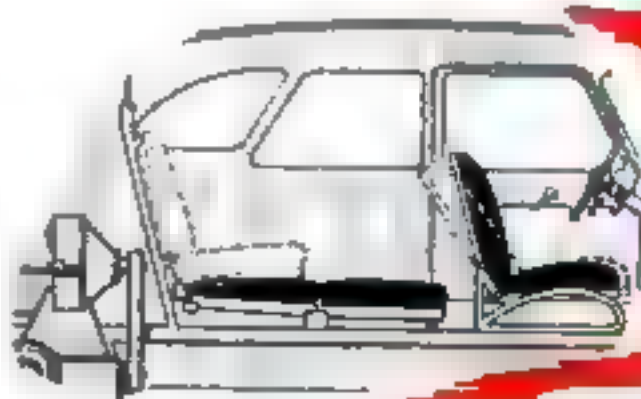


Body is a one-piece plastic shell that has its strength throughout, like a sphere. Wheels and air springs are assembled into the wells.

designed the "Forty-Six." The Fiberglas plastic that was used in the body is lighter than steel. Air springs, made of Fiberglas and rubber cushions, are lighter than standard steel springs and shock absorbers. A specially thin sidewall design slices three pounds from each tire. Future plans to install an aluminum air-cooled engine will cut off another 300 pounds.


For all its lightness, the car rides smoother than many standard makes because of a suspension that hangs the body between the springs. A low center of gravity leans the car into the turns. Steering is quick and easy.

There are no plans for putting the "Stout Forty-Six" on a production line. Designer Stout calls his car just a \$10,000 experiment to show what can be done with Fiberglas as a structural material.




Back seat unfolds to make a full-size double bed, six feet long. With rear seat up, there is room for a card table. Driver's seat is fixed, but adjustable; other front seat can be easily taken out.

OUR NEW ATOMIC



The foot of a tribal chief was an early unit of measurement.



A mile was 1,000 paces, the pace being five feet. Romans introduced it into Britain.

THE science of precision measurement, visibly fruitful in low-priced automobiles, eyeglasses, and air conditioning, may wrest more secrets from matter of all kinds with a new, incredibly accurate "yardstick"—if military authorities controlling critical facilities will permit production of necessary material.

The material is a special type of mercury made from gold. When its atoms are excited in a quartz tube with a high-frequency circuit, they emit a green light ray by which measurements 10 times as accurate as those now possible can be made.

The new mercury, Hg-198, could be produced in sufficient amounts to meet all research requirements by diversion of one one-thousandth of one percent of the facilities now being used to manufacture atom-bomb materials by the "pile" system. The only other method of producing Hg-198 is by cyclotronic bombardment of gold with neutrons. This process takes at least one year and only infinitesimal quantities of the new mercury are derived. Only a few millionths of a gram have thus been produced. These have been strictly rationed, with about one millionth of a gram being placed in each "measuring lamp." The life of such a lamp is only a few minutes.

However, there is one lamp containing Hg-198, which was made by the "pile" system, in the Spectroscopy Laboratory of the U. S. Bureau of Standards at Washington. Considerable mystery surrounds the origin of the mercury. Obviously, it was synthesized, quietly and unofficially, by a friendly scientist working in one of the atom-bomb establishments, and sent to the Bureau. Dr. William F. Meggers, internationally known physicist who heads the Spectroscopic Lab, declares he doesn't know where the material came from—but Dr. L. F. Curtiss, Chief of the Radium Section, did

YARDSTICK

Indestructible standard brings science still closer to precision.

This cigarette-size lamp contains pure mercury made from gold by the atomic pile. Rays measure billionths of an inch.

make a lamp from it. Even though the Hg-198 was improperly processed, and came through containing impurities that had to be boiled off, enough was recovered to make a lamp which has lasted a year, during which it has been illuminated for several hours. Dr. Meggers doesn't know how much Hg-198 there was originally, or still is, in the lamp, but undoubtedly it was more than the total produced by neutron bombardment in the cyclotron.

That "science is measurement" is axiomatic. Without the ability to measure in hundred-thousandths of inches, the tools that make possible the production of interchangeable automobile components, which in turn make possible assembly-line technique and quick repair, could never have been built. Eyeglasses, cameras and other optical instruments would never have become widely available. Likewise, refrigerators, air-conditioning units, musical instruments and countless other benefits.

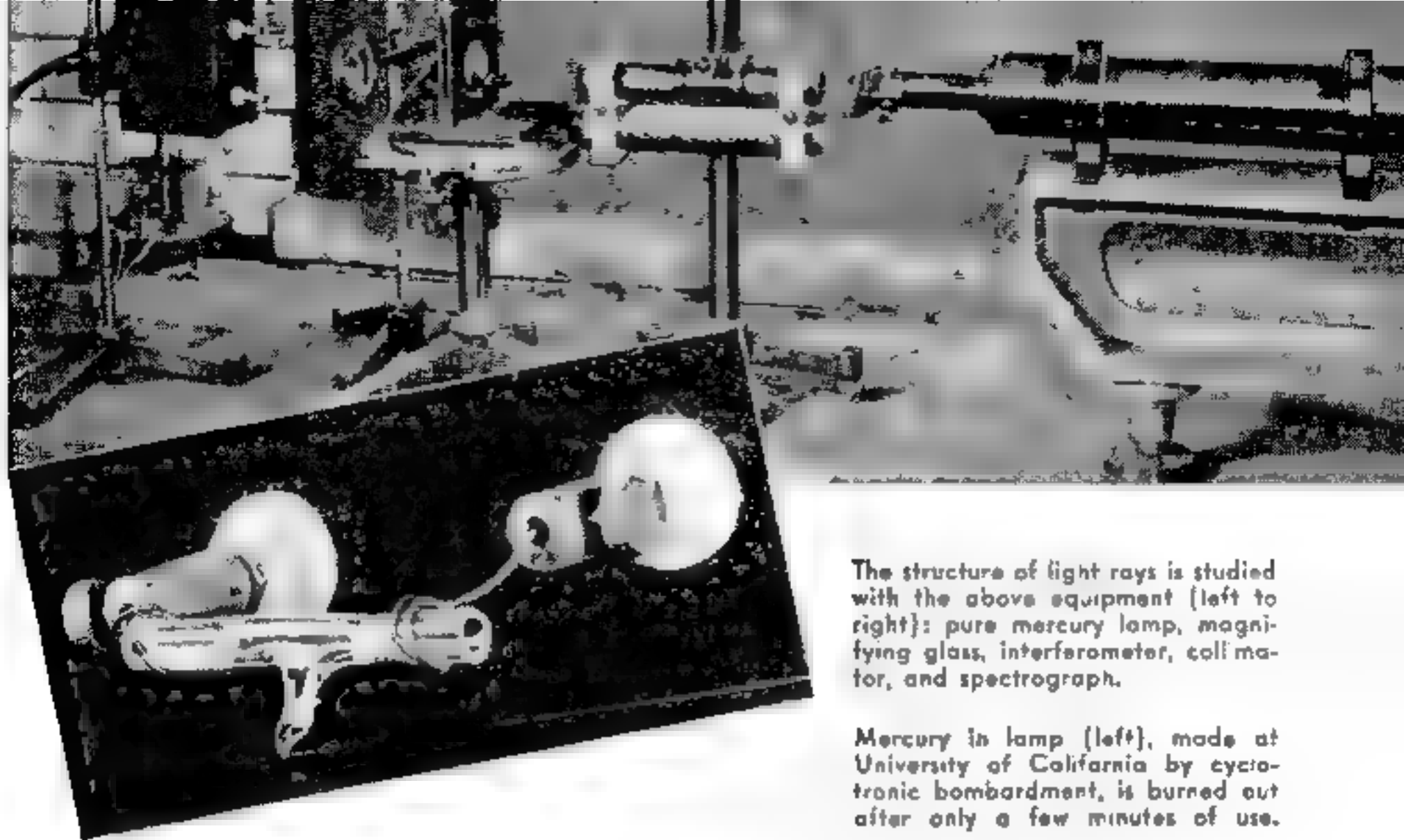
But these visible applications of science all sprang from fundamental research. When Drs. Jacob Wiens and Luis W. Alvarez were seeking to transmute gold into purified mercury, they had no specific application in mind. They were engaged in fundamental research, striving to free further secrets from nature's prison. Their success, in 1940, permitted eventual development of the new means of measurement, which in turn is making possible a more accurate determination of the velocity of light. Present means of measurement are easily adequate for mechanical needs—checking of micrometers, precision-gauge blocks, precision-line standards and the like. For these, measurements in hundredths of thousandths of inches suffice. But who is to say what new



FSM Photos by HUBERT LUCKETT
Drawings by RAY PLOCH

boons to mankind may be made possible by the ability to measure in *billionths*?

The metric system, which became the international system and with which came a golden age of scientific progress, was recommended to the French National Assembly in a report by the Paris Academy of Sciences in 1791. Similar recommendations had been made as far back as 1670, but it was 1875 before a treaty was signed providing for an International Bureau of Weights and Meas-



The structure of light rays is studied with the above equipment (left to right): pure mercury lamp, magnifying glass, interferometer, collimator, and spectrograph.

Mercury in lamp (left), made at University of California by cyclotron bombardment, is burned out after only a few minutes of use.

ures. The metric system is now either obligatory or permissive in every civilized country in the world, and has been adopted generally as the scientific language of measurement. At the International Bureau of Weights and Measures, at Sevres, France, are kept the International Prototype Meter and Kilogram—the official world standards of measurement. Copies are held by countries signatory to the International Metric Convention.

But scientists realized early that the meter standard held at Sevres was not ideal, for at least two reasons: (1) a bad jolt might rearrange the crystals in the bar and cause a change in the length line; (2) to check various measuring instruments used in science and industry throughout the world, the instruments have to be brought to one of the standards. Some standard that could be reproduced anywhere at any time, and that could never change, was desired. This was discovered in the light wave. In 1893 Prof. Albert A. Michelson, who in 1907 was to become the first American physicist to win the Nobel Prize, measured the length of light waves emitted by the spectroscopic red line of cadmium. Using interference phenomenon as a counter he measured the meter standard in terms of these light waves. In 1907 the International Union for Cooperation in Solar Research adopted 6,438 4696 angstroms, the wave length of the red line of cadmium, as the definition of

the unit of wave length. (There are 254,000,000 angstroms in an inch.) This figure agrees closely with the Michelson value.

In 1927 the wave-length standard was provisionally adopted by the International Committee on Weights and Measures as 1,553,164.125 wave lengths equalling one meter. So the cadmium light wave, known for its uniformity of length and its indestructibility, became the practical basis for measurement. Infinitely precise measurements could be written on a scrap of paper in terms of light waves, sent anywhere, and reproduced at their destination in the same terms. Today, an atom bomb, bursting at Sevres and vaporizing the international meter standard, while other atomic explosions destroyed all the copies, could not produce the confusion which attended the damaging of the English yard standard in 1834 when fire consumed the Houses of Parliament, in which the standards were kept.

But even cadmium, best of the natural-light sources for measuring, has disadvantages. It has to be heated to 620.6 degrees Fahrenheit, necessitating use of a furnace and making for a complicated operation. With cadmium the interference patterns, in which the number of waves is counted, disappear at 500,000 wave lengths, which makes measurement of any object longer than about one-fifth of a meter impossible without repeating intricate adjustments. Further, the red light given off by



International Prototype Meter, a platinum-iridium bar that is the official world standard of measurement, is not absolutely accurate. But distance from the center line of three vertical lines at one end of the bar (above) to a similar line at the other end of the bar marks accepted length of one meter.

cadmium is not the color most easily discernible by the eye. Heavy atoms are desirable because they emit a purer wave, and cadmium atoms are not as heavy as mercury atoms.

Hg-198 meets all these objections and provides additional attractive features. Heat of -369.4 degrees Fahrenheit is ample. Interference patterns will be visible up to 4,000,000 wave lengths, which means that objects over one meter in length can be measured directly. The green light of Hg-198 is at maximum visibility. Its heavier atoms, plus the low temperature at which they may be made to glow, make the ideal combination for a light measurement source.

Dr. Meggers 15 years ago proposed a search for a source of more accurate wave-length measurement, which would permit a comparison with the meter standard in a single operation. One of the reasons he wanted such a check is this little-known situation: When the international meter bar was set up, the demarcating lines were crudely scratched on, several microns wide. Now that measurements in tenths of microns are desired, great difficulty is encountered in trying to determine the exact center of the multimicron lines. Unless the exact center of these lines can be established, precise length of the meter cannot be determined. Such uncertainties are abolished by substituting end gauges for ruled scales, and measuring with light waves. The red line of cadmium is four-thousandths of an angstrom

wide. The green line of mercury is *four ten-thousandths* of an angstrom wide—permitting measurements 10 times as accurate as the most precise “yardstick” heretofore known! (Remember there are 254,000,000 angstroms in an inch.) The new mercury writes like a finely sharpened pencil, cadmium like a blunt piece of chalk!

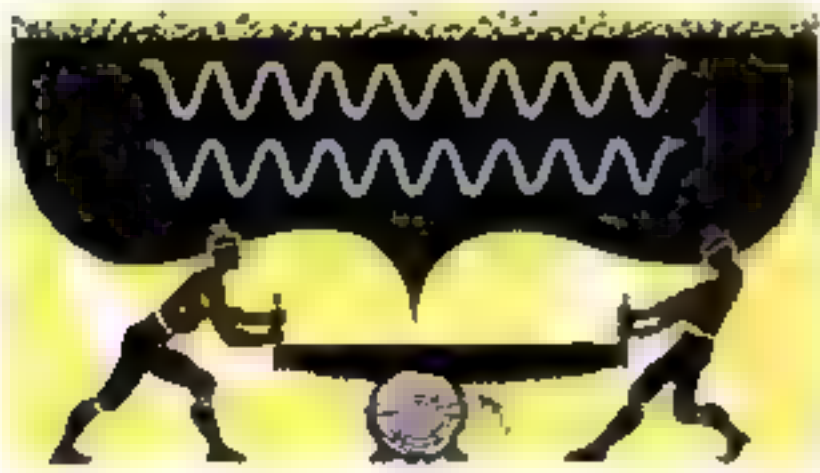
It is probable then when enough of the new mercury can be produced, and sufficient continued production assured, the green line of mercury, with a wave length of 5,461 angstroms, will replace the red line of cadmium, with a wave length of 6,438 angstroms, as the primary standard of wave length.

When Drs. Wiens and Alvarez began their research at the University of California at Berkeley, they knew that natural mercury was an excellent source of light, but all its spectrum lines are complex because natural mercury consists of six slightly different kinds of atoms (isotopes), which emit slightly different wave lengths. Nuclei of atoms containing an uneven number of positive electrical charges spin in such a way as to produce hyperfinesness and fuzziness, while those with an even number of positive charges give different wave lengths. In other words, isotopes of the same element behave differently. The problem was to produce the desired isotope of mercury. So the scientists reversed the alchemist's dream and sought to transmute gold into an isotope of mercury that would meet their requirements. Here is what they did:

Gold sheet was rolled and put into a fused quartz tube. This was attached to a pump and placed in an induction furnace. Temperature was raised almost to the melting point of gold, all volatile matter (impurities, gases, etc.) boiled off, and the tube sealed. This then was subjected to bombardment with neutrons in the cyclotron. The gold atoms “captured” the neutrons, became radioactive, emitted electrons, and turned into mercury of atomic weight 198. Heating the gold drove the mononuclear mercury into a tiny tube, which was sealed off and excited by radio frequency to emit light. Therefore, when viewed through a spectroscope, which separates light into its component parts—the green line of 198 was produced with superior sharpness.

Thus the scientists produced a permanent and reproducible standard of length that surpasses anything and everything that Mother Nature has provided.

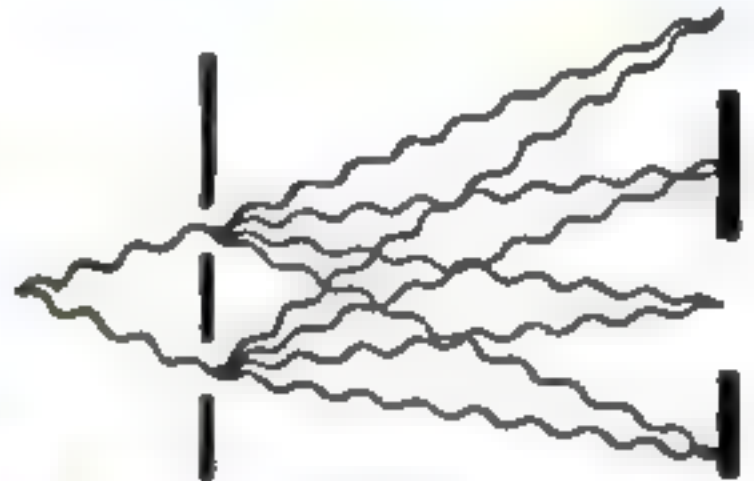
How to Measure by Light Waves



1. If two light waves are superimposed and their relation to each other is such that the peak of one coincides with the peak of the other and the troughs coincide in the same way, the two waves are said to be "in phase." Thus, they will work together to produce a brightness greater than either could if taken individually.

2. When peak of one wave matches the trough of the other, they nullify each other and limit brightness.

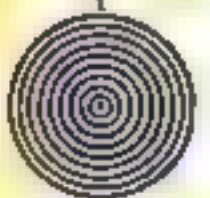
3. If light from one source is separated into two beams and passes through two parallel slits, a pattern of alternate light and dark lines forms behind the slits. Light lines result from beams traveling equal distances or distances varying in whole wave lengths. If path difference is in half-wave lengths, dark line appears.

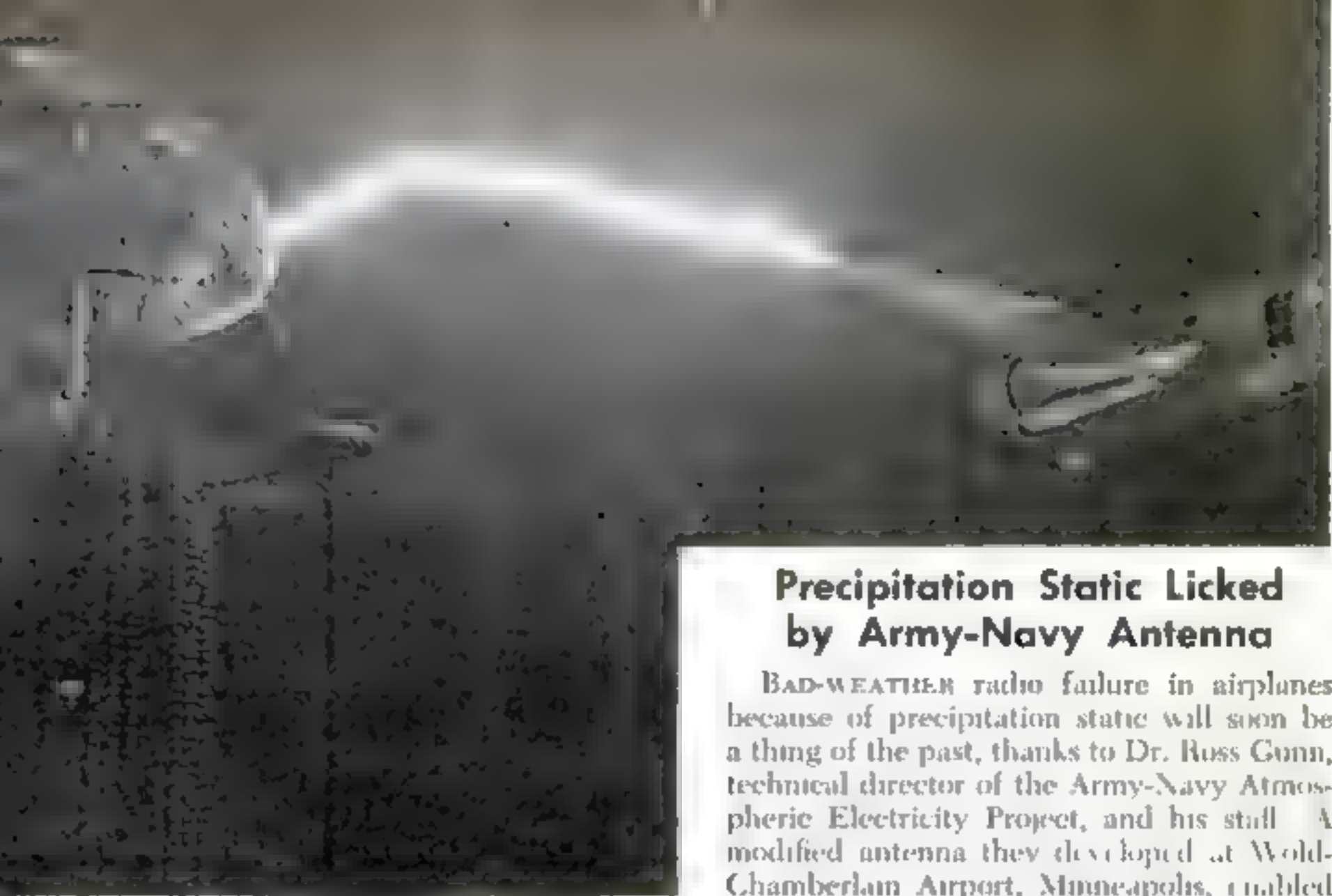


4. A machine part and a gauge rest on a plane base plate (right). Above, artist's elevation drawing shows how reflected light through test glass forms interference pattern on the two surfaces (circles). Dark lines indicate thickness.



5. This diagram of an interferometer shows how light waves can be used to measure an unknown distance. Space between A and B (silvered mirrors) is measured in wave lengths of monochromatic light by counting the number of fringes that appear while moving A back and forth. When the eye sees a uniform white field through mirrors D C, B and A, there is no path difference, and since the distance from A to B is known, that from C to D can be computed.





Precipitation Static Licked by Army-Navy Antenna

BAD-WEATHER radio failure in airplanes because of precipitation static will soon be a thing of the past, thanks to Dr. Ross Gunn, technical director of the Army-Navy Atmospheric Electricity Project, and his staff. A modified antenna they developed at Wold-Chamberlain Airport, Minneapolis, enabled operators in a suspended Vega Ventura plane (above) to obtain excellent radio reception despite nearby 1,200,000-volt flashes of man-made lightning.

Precipitation static is the noise caused in aircraft radio receivers when a plane flies through particles of ice, snow or dust or through highly charged electrical clouds. The voltage on the airplane may build up as fast as 170,000 volts per second. This charge soon breaks down the air around the plane, and an automatic electrical discharge, called corona, takes place at the wing tips. Sailors call the corona St. Elmo's fire.

march of SCIENCE

Photographing Fuel Combustion

NEW facts about fuel combustion are being discovered at the University of Wisconsin with an electro-optical pyrometer (fire meter), which measures the temperature and pressure of exploding gases. Light from explosions within a single-cylinder Diesel engine passes through a quartz window (A) in the cylinder wall to a photoelectric cell (B), which responds instantly to variations in light intensity corresponding to various temperatures of the combustion process. An oscillograph records the impulse aroused in the photocell and a special camera photographs the oscillograph.

The pressure indicator (C), also in the cylinder wall, is a diaphragm of strong, heat-resistant Inconel, a metal that retains a high polish at extreme temperatures. As the diaphragm bulges under the pressure of explosions it reflects a beam of light to another photoelectric cell at (B) and a similar recording process takes place. Pressure also can be "photographed."



Photo by Gary Scholz

Talking on a Beam of Light

GERMANS called this invention a *Lichtsprecher*, or light-speaker. Americans captured it and found that it sent messages on a beam of light. The system converts sound into varying light pulses that are focused on a distant, photosensitive receiver, which changes them back into sounds audible in a headset.



Duplicating German Dyes

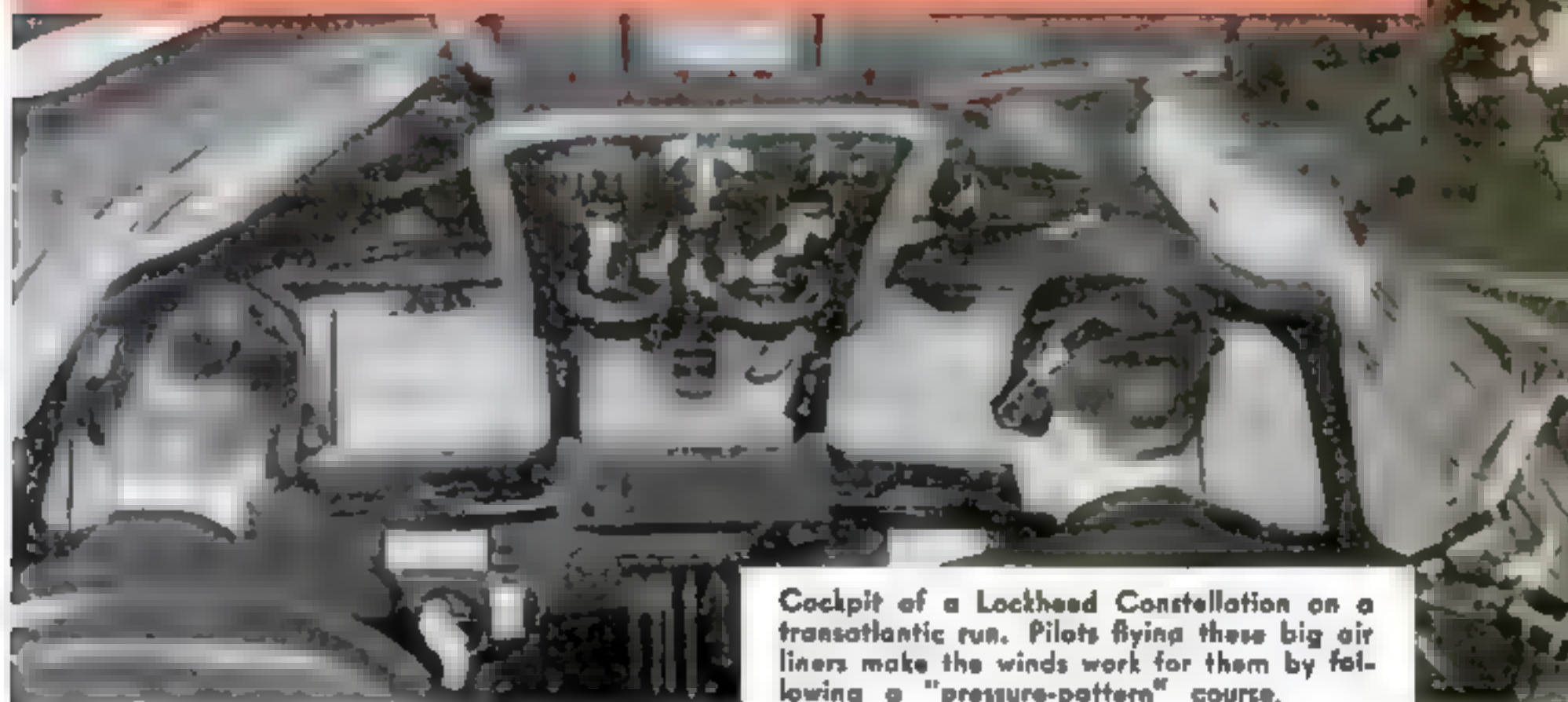
Two hundred out of about 350 dyestuffs once manufactured only in Germany are now being duplicated in American factories because of intensive research by General Aniline and Film Corp.'s technicians at Easton, Pa. laboratories. The technicians, including more than 60 Ph D.s in chemistry, are making an intensive study of the chemistry of colors and their manufacture. Photograph at left shows a research worker using a fractional distillation column to purify a liquid made up of small molecules.

Draftsman's Delight

Through cross hairs in the eyepiece of this aid a draftsman sights salient points of an object or design, each time pressing a button that causes an electrically actuated pencil to transfer the points to a drawing board. Points then are joined and shaded by hand.



Thumbing Rides on Storms



Cockpit of a Lockheed Constellation on a transatlantic run. Pilots flying these big air liners make the winds work for them by following a "pressure-pattern" course.

How planes flying the Atlantic save time by going farther

By GEORGE H. WALTZ, JR.

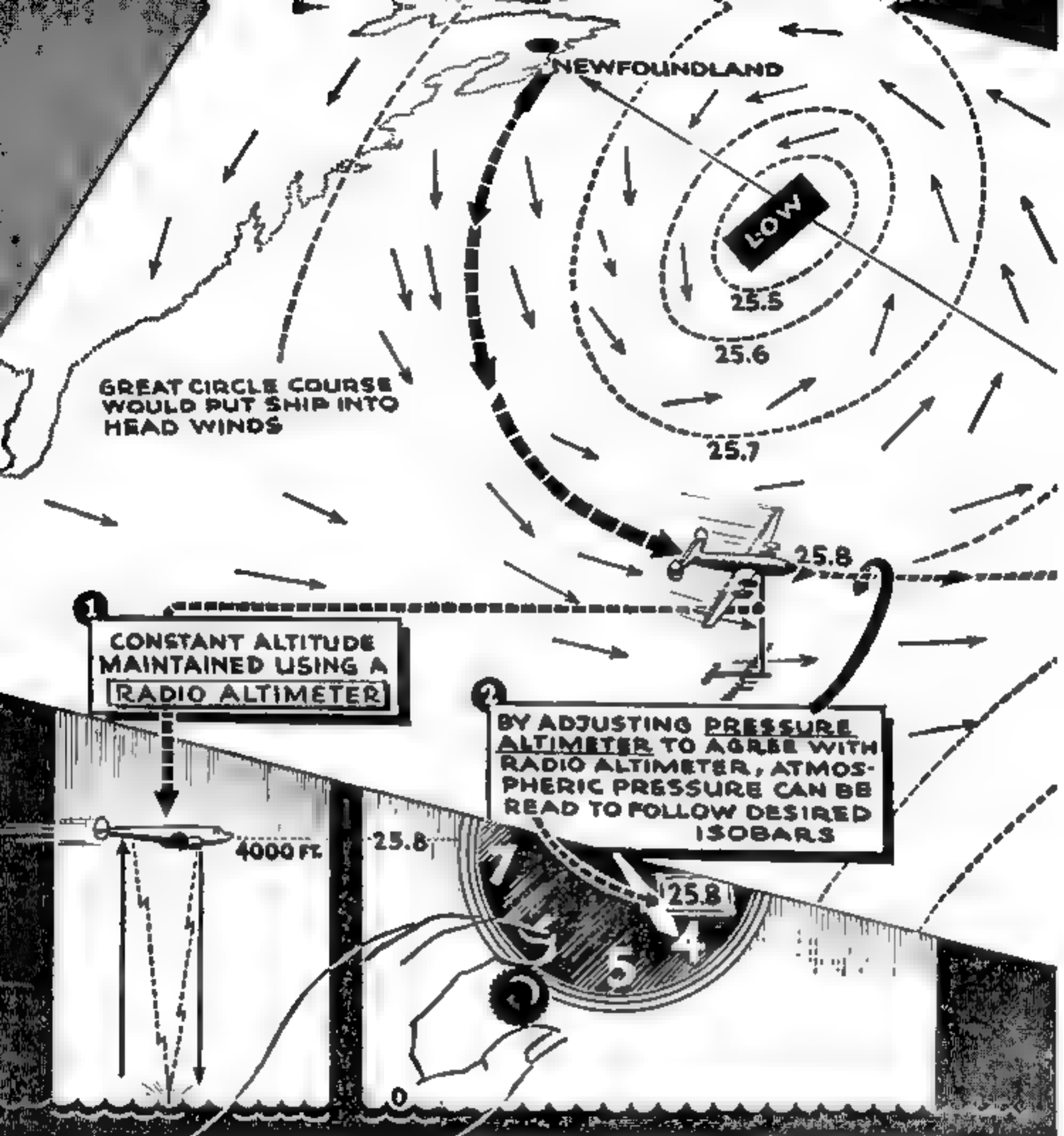
THE longest way around is actually the shortest way across for pilots on the Atlantic hops. They now make the most of the strong ocean winds—even though it means flying an S-shaped course—to get from here to there faster, with less gasoline, and with greater safety and comfort.

The basic principle—mainly a matter of making the winds work for the airplane instead of against it—was developed during the war when it was vitally important to fly men and materials to England as fast and as regularly as possible. Much of the groundwork was done by veteran civil-contract pilots and crews borrowed from Transcontinental and Western Air, Inc., to man the Army Air Transport Command's North Atlantic fleet of big, four-engined C-54s (DC-4s, the airlines call them). "Pressure-pattern flying," as the technique is called, evolved from their day-by-day experiences shuttling between bases in Newfoundland and Scotland, and from the endless data collected by the expert crews of weather ships that flew night after night regardless of storms, sleet, and ice.

Storms do not just happen—they develop, and the process takes time. Working with latest, accurate information on the wind velocities aloft, barometric pressures, and the air temperatures at various altitudes, an airline weather man can predict with amazing accuracy just what the weather over the ocean will be. With careful plotting of this information, he can draw a detailed map of the "weather system," locating the Lows (low-pressure areas), the Highs (high-pressure areas), and the probabilities of storms, fronts, and icing conditions. A weather system may move—it may drift north or south, east or west—but it will remain basically in the same general formation for from eight to 10 hours.

Let's look at a typical North Atlantic weather system. Traveling from west to east there is a Low and then a High. The winds in a Low in the Northern Hemisphere *always* blow counterclockwise around the center of the pressure area. The winds in a High *always* blow clockwise. In the Southern Hemisphere the winds are reversed. In the center of a Low there is generally bad weather, and in the center of a High there may be rough flying.

To fly a straight-line course from an airport in Newfoundland, the last refueling

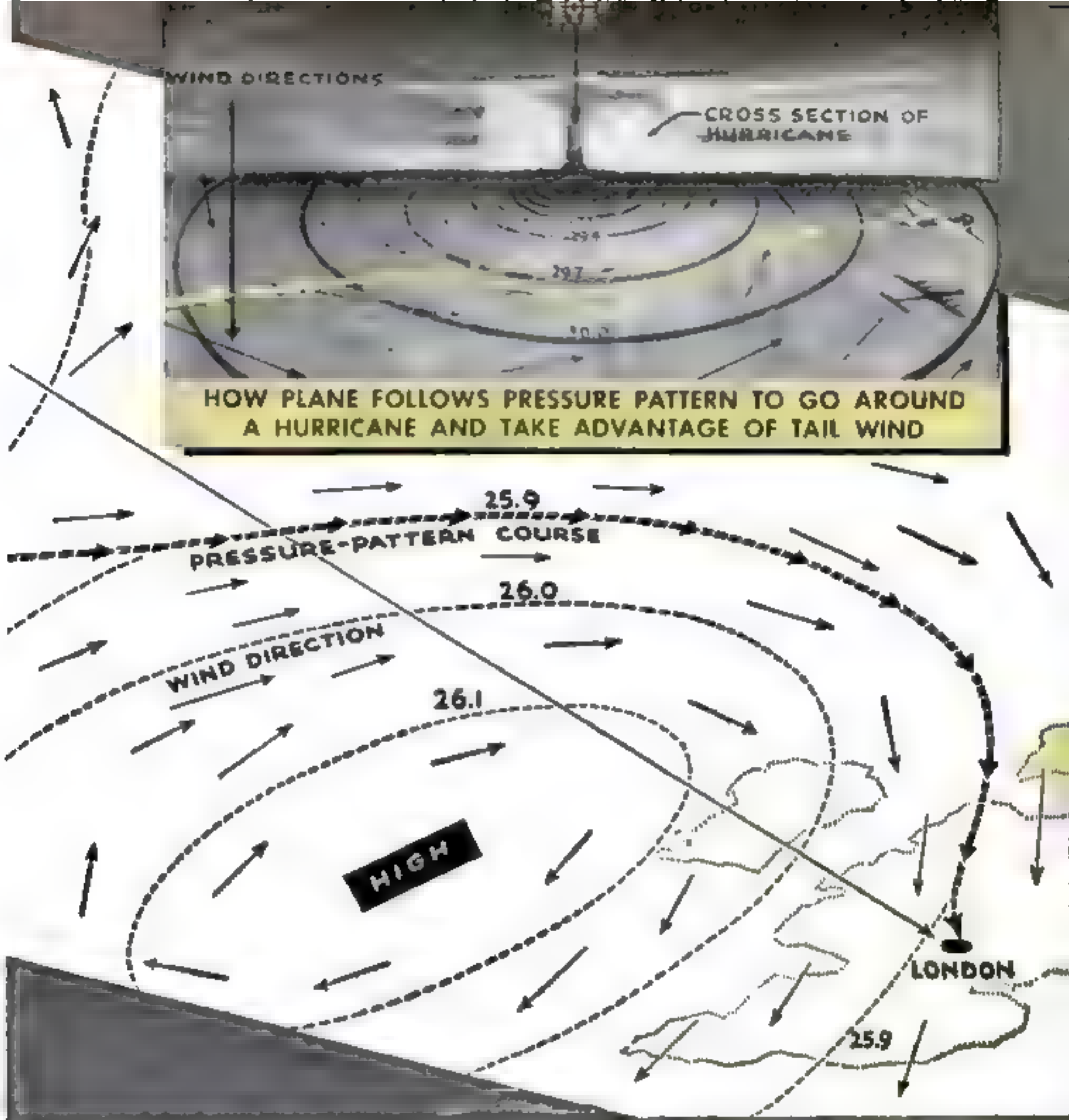


stop, to London an airplane would have to fly close to the center of the Low and toward the outside of the High. This would mean at least three or four hours of rough going through the low-pressure zone. More than that, a study of the winds shows that the plane would have to buck a 45-mile-an-hour head wind while flying through the Low and a 40-mile-an-hour head wind through the fringes of the High. Head winds mean more fuel and time consumed to cover the distance. An airplane flying 200 miles an hour (what pilots call "air speed") into a 40-mile-an-hour head wind covers only 160

Weather maps indicate Highs and Lows by concentric lines called *isobars*, labeled with their atmospheric pressures. The pressure decreases toward the center of a Low and increases toward the center of a High. If you were to fly around the edge of a High

miles over the ground or water in an hour. On a 2,000-mile flight that means two and one-half hours longer than normal to make the trip. And a big four-engined transport like the DC-4 consumes several hundred gallons of gasoline every hour.

Flying these same conditions by the "pressure-pattern" method, the pilot and navi-



or a Low along one of these isobars, the atmospheric pressure would remain constant and, once adjusted, the reading of your pressure altimeter would match the reading of your radio altimeter. This is exactly what a pilot does in pressure-pattern flying.

gator with the help of the all-important weather man would plot a course along the southern edge of the Low and the northern fringe of the High. Instead of hindering head winds, they now will have helping tail winds all the way. The counterclockwise winds of the Low will give them a boost during the early stages of the flight and the

clockwise winds of the High will add to their speed over the final stretch. Instead of severe turbulence through the Low, they will have smooth flying over the entire route. They will fly an S-shaped course—probably increasing the actual distance flown by one-third—but they will get there faster, use less fuel, and have fewer airsick passengers.

In principle, pressure-pattern flying is simple and logical. Development of the radio altimeter made the scheme workable. By using it in conjunction with the conventional pressure altimeter, the pilot and navigator literally can feel their way through

the Highs and Lows to follow the most advantageous course.

The conventional altimeter on an airplane's instrument panel is a pressure-operated instrument—its needle is moved over the dial by a metal bellows that expands and contracts according to the pressure of the atmosphere. To be accurate, it must be adjusted to the atmospheric pressure of the area manually, by means of a small knob. This shortcoming is put to good use in pressure-pattern flying, however, for conversely, if the exact altitude is known, the same knob can be used to set the altimeter needle to that altitude and the atmospheric pressure at that altitude can then be read from the pressure scale on the instrument's dial.

The radio altimeter, because it functions by aiming a radio impulse at the ground and measuring the time it takes to bounce back, is accurate to within 50 feet. It does not depend on atmospheric pressure for its reading and therefore requires no atmospheric-pressure adjustment for accuracy. In pressure-pattern flying the inaccuracy of the pressure altimeter and the hairline accuracy of the radio altimeter work hand in hand. By using one with the other, pilots and navigators make the winds work for them.

For the moment, let's take over the co-pilot's seat in an airplane. In front of us, along with lots of other indicators, lights, gages, and dials, is the pressure-altimeter dial. Near it is the dial of the radio altimeter. According to the radio altimeter we are cruising along at 8,000 feet. The pressure altimeter, however, shows a reading of only 7,800 feet, which means that the pressure altimeter is not adjusted to the atmospheric pressure of the area through which we are flying. If we turn the adjustment knob until the needle points to our actual altitude of 8,000 feet we can then read the actual atmospheric pressure directly from the dial. By continuously adjusting the pressure altimeter to agree with the reading of the radio altimeter we can always know the atmospheric pressure at every point along our course—and therein lies the secret of pressure-pattern flying.

When plotting their proposed course prior

to a flight, the pilot, navigator, and weather man first rough out a route so as to take full advantage of the winds. Then, in order to make it easier to fly that approximate course, they alter it slightly to coincide with a convenient isobar in the weather map's Low and another isobar in the High. The chosen isobars, or lines of equal atmospheric pressure, then become their road in the sky. They follow it just as you follow signposts.

Once in the air, they use the conventional methods of navigation—radio, Loran, and sextant—to follow their general course, but by continually readjusting their pressure altimeter to agree with their radio altimeter they have a continuous check on the atmospheric pressure of the area through which they are flying. Should they stray far from their chosen isobar, *a difference in the pressure reading will not only tell them immediately that they are straying but in which direction.*

There are complications, naturally. Weather systems do change, but here again the pressure altimeter and the radio altimeter, working hand in hand, let them know of the changes and help them to alter their course accordingly. If the shape of an isobar changes because of some atmospheric development, the readings of their pressure altimeter will help them to follow its slight curves and turnings. Pressure-pattern flying is not a substitute for navigation by the usual methods; it is an important aid.

Pressure-pattern flying has been used principally for flying the ocean. The air lines, realizing its worth, are experimenting to apply its principles to flights over land, where additional factors enter the problem. The radio altimeter indicates altitude above terrain and pressure-pattern flying depends on an accurate indication of the altitude above sea level. Variations in terrain—mountain and valleys—complicate the calculations, but a combination of radar to give a moving picture of the ground and the two altimeters to provide the pressure picture may eventually give the answer. In the meantime, trans-Atlantic passengers are flying the winds to get to their destination with fewer bumps and with greater speed.



WHEELAIR 111-A. This all-metal, four-place, pusher-type personal plane will cruise at 120 m.p.h., have a top speed of 135 m.p.h. and a range of 600 miles. A 170-hp. Lycoming engine supplies the power. Produced by Puget Pacific Planes, Inc., it won the PSM Airplane Design Competition in 1945.



BRILLIANT

MIDGET



Pin-point arc with liquid filament may make movies clearer.

By HARTLEY E. HOWE

A BLAZING speck of liquefied zirconium dazzles the eye with one-sixteenth the light of a corresponding piece of the sun. Put in an electric light bulb, it provides a lamp combining intense brilliance and an extremely small light source with sturdiness.

Zirconium, known since 1786 and previously used in ceramics, is a metal with a high melting point. It exists in various ores found principally in Colorado and Brazil. Zirconium oxide was used in the first gas mantles and in a German experimental bulb nearly 50 years ago, but its latest application is a war secret just revealed. The sensational new bulb was developed by Western Union researchers seeking to devise better tubes for communications. Now on the market in 2- to 100-watt sizes, the bulb is declared by its developers to offer possibilities of better movie projection, clearer and sharper optical magnification.

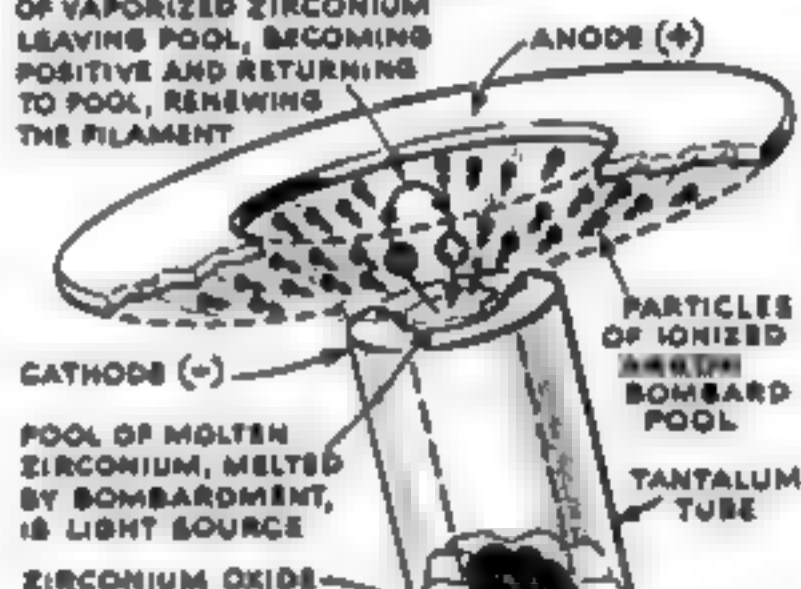
Wholly new is the use of a liquid instead of a solid or gas filament. Zirconium oxide is placed in a hollow negative electrode, enclosed with its positive partner in a bulb filled with argon, an inert gas. Heated electrically, the zirconium oxide becomes a conductor, loses its oxygen, and melts to pure zirconium. In this state it is bombarded with argon ions so that it glows brilliantly.

The light is much whiter than that of the tungsten filament, and unlike that of the mercury arc it contains all wave lengths of the spectrum. It is high in ultraviolet content—which may make it useful for medical treatments—and very active photographically, cutting exposure times.

Each square millimeter of liquid zirconium produces about 100 candlepower of light, 10 times that of tungsten but slightly less than that of the carbon arc. In comparison, the sun has about 1,600 candlepower per square millimeter of surface. Western Union engineers have produced lights of intensities half that of the sun, but at present they are uneconomical.

The glowing zirconium in the smaller bulbs is practically a pin point. Like a pin-

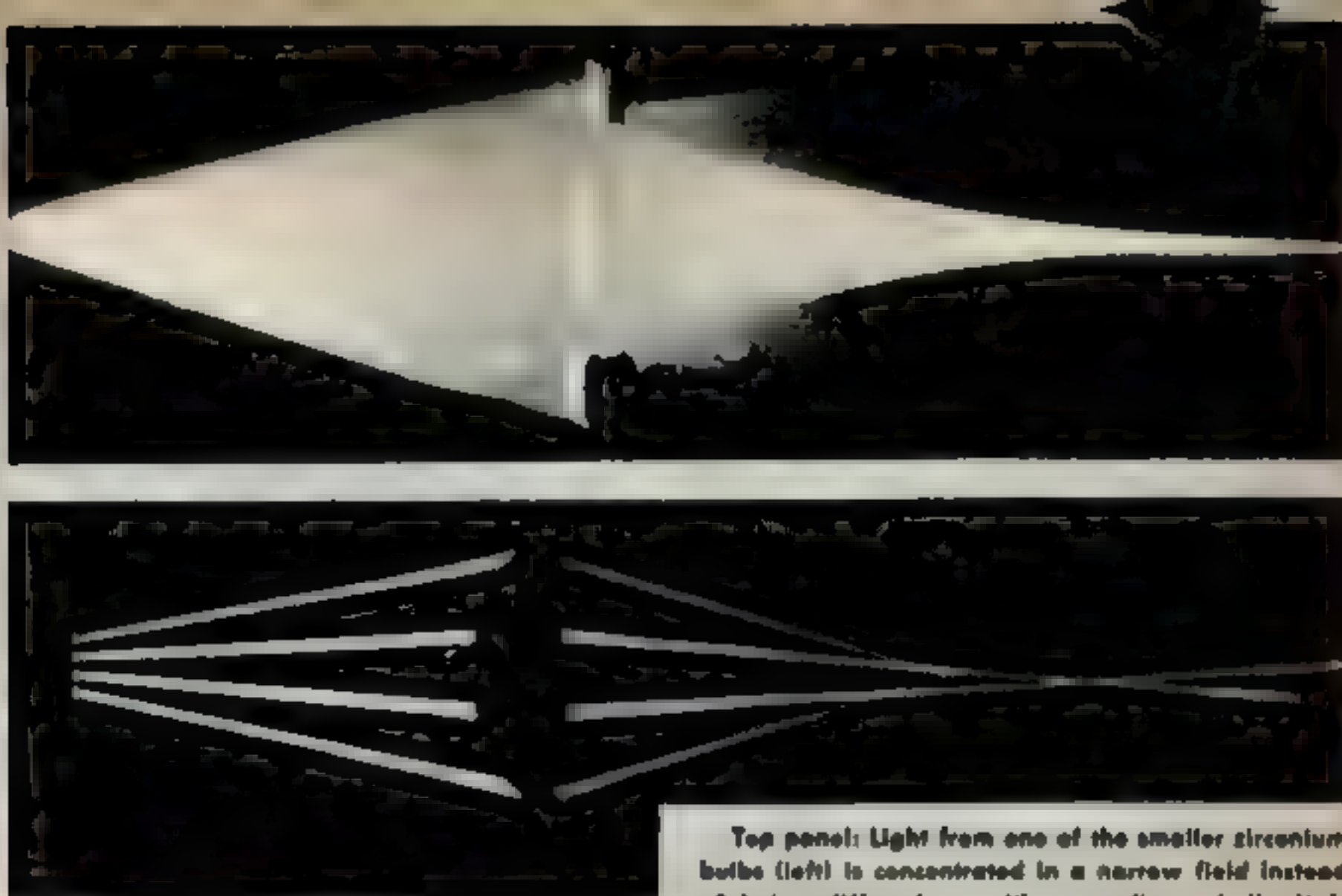
PATH OF A NEGATIVE PARTICLE OF VAPORIZED ZIRCONIUM LEAVING POOL, BECOMING POSITIVE AND RETURNING TO POOL, REHEWING THE FILAMENT



The tiny arc largely renews itself, ionization causes most of the zirconium that rises in vapor particles to return, but a little is lost each time the bulb is used. Average life of a bulb, depending on size, is 175 to 1,000 hours.

point camera it will project an image without a lens. The transparency can be tilted to produce a distorted image, and the infinite depth of field prevents fuzziness, as there would be with a lens. The small source also makes it possible to use the lamp to test and demonstrate lenses without the elaborate apparatus needed to produce a pin-point source of light in an optical laboratory.

The bulb has obvious possibilities for photographic enlarging, but requires a new optical system. Because of the light's intensity and its concentration in one direction, it shows up any flaw in a negative or condenser—dust specks, fingerprints, strain lines in the glass—usually concealed by the



Top panel: Light from one of the smaller zirconium bulbs (left) is concentrated in a narrow field instead of being diffused as with an ordinary bulb. It is being used to test a lens.

Bottom panel: Here the light of the bulb has been split into four parts to reveal the aberration of an uncorrected lens (rays fail to converge).

Below: The concentrated arc projects sharp images on a wall without a lens. Here it has been placed behind a piece of coarse cloth and a fragment of coral. Shadows are clear despite their great enlargement.



Photos by HUBERT LUCKETT

diffusion of an ordinary lens's optical system.

More immediately practicable is the use of the bulb with high-power microscopes. Prof. Harry L. Smith, head of the Physics Department at Michigan State Normal Col-

lege, has used both the 10- and 25-watt bulbs as a light source below the microscope. He reports to *Popular Science Monthly* that "there was plenty of light and the definition was greatly improved over that obtained with the ordinary light source."



Filming Every Foot of a Race.

From six high towers around the track, trained cameramen make a complete, 16-mm. movie record, through telephoto lenses, of every horse race at Hollywood Park, Calif. After the horses cross each cameraman's assigned area, he slides his magazine of film down a wire to a waiting car, which rushes it to a special lab under the stands. It may be shown in eight minutes. Photo control has reduced rough riding, prevented undeserved fines.

First of 500. This sleek, two-place, Bell helicopter is the spruced-up production version of the basic design for which the first commercial helicopter license was recently issued. Able to carry more than the usual helicopter load ($\frac{1}{2}$ gross weight), it cruises at 80 m p h. The aircraft has two rotors, the big one, with a span of 34 feet, whirling 333 times a minute; the little one on the tail revolving five times as fast as that. The Bell rotor system is unique: there is a gyroscopic stabilizing bar beneath the blades; and the blades are not hinged. The company is making 500 of this model, and also has a five-place model in production.





POISON IVY, the weed nobody loves, is shown above in a healthy state of growth. Seven days after it was sprayed with a 2,4-D solution, it looked as it does in the picture at the right. The internal effect on the ivy was very similar to that of freezing



downy foes of Grass

New chemical selects its victims among broad-leaved plants.

THE home owner now can weed his lawn with a spray instead of a back-breaking fork. Hay fever sufferers can look forward to a deadly attack on their enemy, ragweed; and the farmer is promised help in keeping unwanted plants out of his fields. For substances that mean life and growth to the plant world have been converted to a brew of death by scientific research

The new weed killer is a chemical called 2,4-D (contraction of 2,4-dichlorophenoxy acetic acid, the numbers indicate the position of the chlorine in the molecule). It works much like the hormones that regulate plant growth. Small quantities stimulate some plants to flower and ripen early, yet larger doses are fatal to many broad-



A DANDELION PLANT (above) is treated with 2,4-D, and three weeks later is done for, as illustrated below. Their broad leaves make dandelions particularly susceptible.



leaved plants. Only minute doses, however, are required to wipe out most weeds.

And 2,4-D is selective. Spray it on a lawn, and many weeds die while most grasses are unhurt. This is the result of 2,4-D's hormone-like action. Broad-leaved plants manufacture hormones in their leaves, then pass them down through the leaf stalk to the stem, and through the trunk to the very tips of the roots, affecting practically every cell. The 2,4-D sprayed on a leaf is similarly carried downward, with deadly results: plant cell walls burst, natural moisture escapes, and the plant dies.

Most lawn grasses escape since they are narrow-leaved, with a different hormone organization. But leaves and stems of the broad-leaved weeds—buckhorn plantain, burdock, cocklebur, mouse-ear chickweed, ragweed, and others—bleach, the underground stem swells and breaks, and before long the roots rot away. This process of dying takes from two weeks to a month.

Care must be taken that crab grass and similar grass weeds (immune to 2,4-D) do not move into the spaces vacated by their dead comrades. This means spraying preferably in early spring, late summer, and early

Fall. Warm sunny days are best for the job, though a season should be picked when the plants are not dried out, for the herbicide works best under moist conditions. Bare patches should be well fertilized to encourage the turf to close up, and if necessary be ~~reseeded~~.

Pure 2,4-D is a white powder, insoluble in water, and available in a number of forms. The really important thing is the actual amount of it in any given solution. In general, it takes from one and a half to three pounds of active material for each acre treated. A separate sprayer should be kept for 2,4-D, since even a small residue will destroy valued shrubs and vegetables. But the weed killer is not inflammable, does not stain, corrode, irritate the skin, or poison man or beast.

Much experimental work remains to be done, however, before the chemical is wholly safe for farmers to spray on their fields and pastures. Professor C. J. Willard, of Ohio State University, points out that most legumes—alfalfa, red clover, soy beans, etc.—when growing vigorously are killed with a single application of 2,4-D.

Therefore, farmers are warned to be cautious, or they might end up in the same pickle as a California vineyardist who enthusiastically bought a large quantity of 2,4-D to kill the dogbane around his vines. The dogbane is still flourishing, but the 35-year-old Tokay vineyard is dead.



LAWN is improved by being sprayed with 2,4-D, whose selectivity means that the weeds are killed while the majority of grasses are unharmed. In dry soil, it may continue to kill some sensitive weeds for more than a year. Care must be taken not to allow the chemical to drift onto vegetables or ornamental shrubs. Minute quantities will kill tomatoes.



A black and white illustration at the top of the page shows several people swimming in the ocean. In the upper left, there is a target with concentric circles. The title 'Fifty Chances a Day to save a life!' is written in a large, stylized font across the top.

Fifty Chances a Day to save a life!

By LEON SHLOSS

EVERY day in July and August an average of 50 persons will drown in the United States. Between May 1 and September 1, no other type of accident will take a greater toll of life, except possibly automobile mishaps, which caused more than 28,000 deaths in 1945 (See PSM, Apr. '46). The grim race between the two destroyers will be close.

Drownings rank fourth in the annual accident rate, being outstripped by automobiles, falls, and burns, but between May Day and Labor Day they are the prime contender for Public Accident Enemy Number One. This year, a tremendous pilgrimage from the cities to water resorts is expected. Approximately 100,000,000 people will go swimming. Nearly 200,000 will be rescued from drowning. About 10,000 will drown!

The country's lifesaving organizations have done a monumental job of protection. During the past 33 years the number of swimmers has increased five-fold, yet the number of drownings has been cut in half. Despite this, there is still one chance in 500 that you will need the help of rescuers every time you enter the water. Last year, when drownings dropped sharply, they still accounted for more deaths than any other type of public accident except automotive.

Swimming accidents are not the only water peril. Nearly 20 percent of immersion deaths occur to persons who are fishing, working in the water, or boating. The popular postwar surge to boat ownership gravely concerns safety authorities. Thousands are buying war-surplus vessels ranging from rubber life rafts to amphibious landing craft. Boat-building companies are swamped with orders. All these customers are potential victims of immersion, especially those who are novices at seamanship and navigation.

The safety organizations—National Safety Council, Red Cross, Boy Scouts, U. S. Coast Guard and others—know why there are so many drownings. Basically, the reason is that 90 percent of those who seek recreation in and on the water either are poor swimmers or can't swim at all. Men are watched most closely by the lifeguards, because two-

thirds of the time it is a man who needs help. The average fellow thinks he is quite an aquatic performer, is susceptible to dares, and usually is ignorant of the hidden dangers created by shifting sands, currents, tides and winds.

Will you, or a member of your family, or a friend be one of the 50 daily victims of drowning this and next month? Not if you adhere to the list of DON'Ts, prepared for PSM by leading water safety authorities and pictured on the two following pages.

If you get in trouble, and IF you are gotten onto land, and if you require artificial respiration, there is about one chance in four that you will be revived. In cases where others require this service, you may have the opportunity to save a life, so you should know what happens when a person drowns, and you should know the most efficient methods of artificial respiration.

When a person drowns, he is actually suffocated by inhalation of water during violent efforts to breathe. The brain is denied its customary supply of oxygen and begins to lose its function. The victim becomes unconscious, stops breathing. Life may or may not be extinct. The body is wet and evaporation is reducing body temperature, making death all the more certain. Artificial respiration is required immediately.

Modern artificial respiration was first attempted, in a primitive fashion, in 1774, on the advocacy of the Royal Humane Society. The pipe of a bellows was inserted in one nostril and the other nostril was closed. Air was forced into the lungs and then expelled by pressing the chest. Thus respiration was imitated. About the middle of the 19th century improved methods were introduced by Drs. Hall, Silvester, and Howard. In 1903 Dr. E. A. Schafer of Edinburgh, Scotland, devised the prone-pressure method. In 1927 the U. S. Public Health Service adopted a standard technique for this method, and many other American organizations followed suit. The Red Cross is its particular champion.

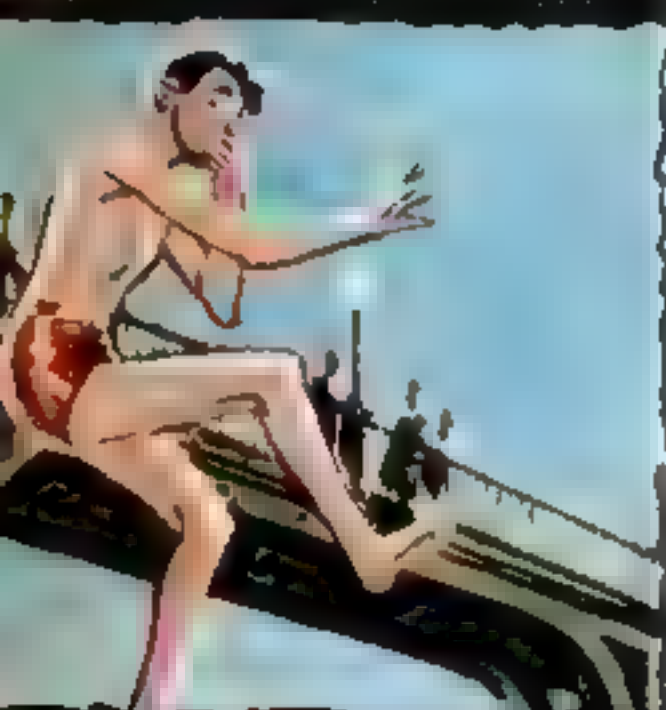
Two years ago Dr. Frank C. Eve, of England, disclosed a new method of resuscitation. The Eve method stresses circulation and warmth directed to (Continued on page 105)



DON'T Swim where there are no lifeguards.



DON'T Swim in heavy surf unless you are a very strong swimmer.



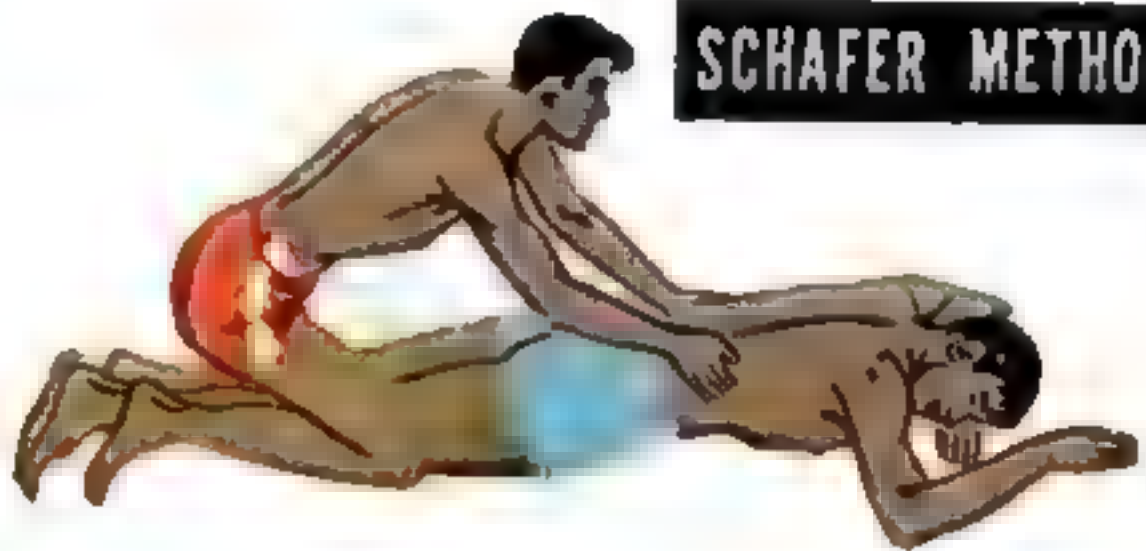
DON'T Dive from high places unless you are an accomplished diver.



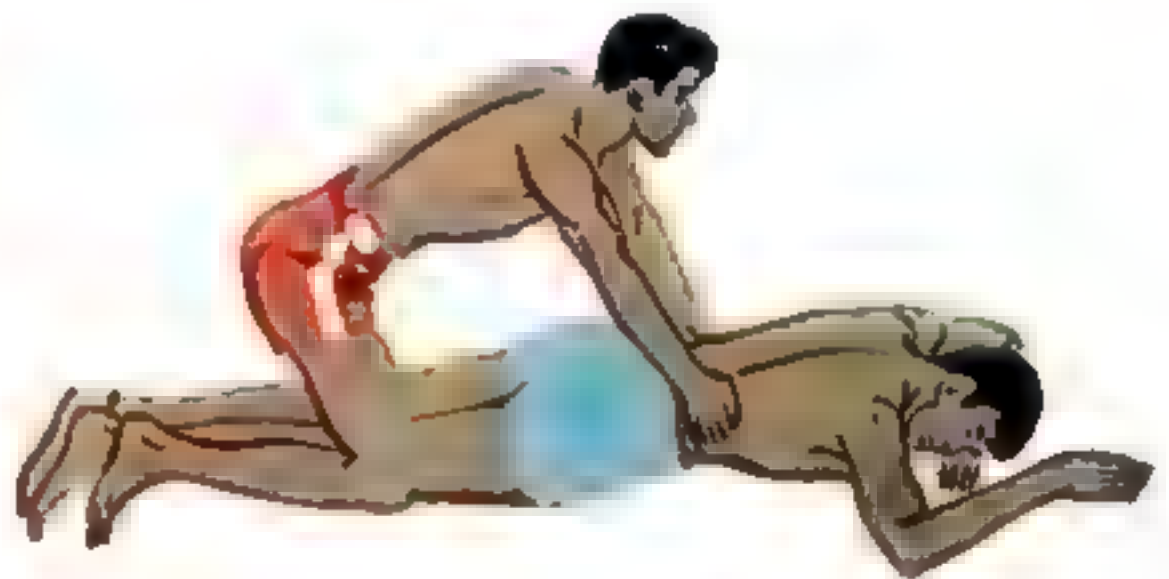
DON'T Swim where there are strong currents or other hidden dangers.

2 WAYS of SAVING LIVES

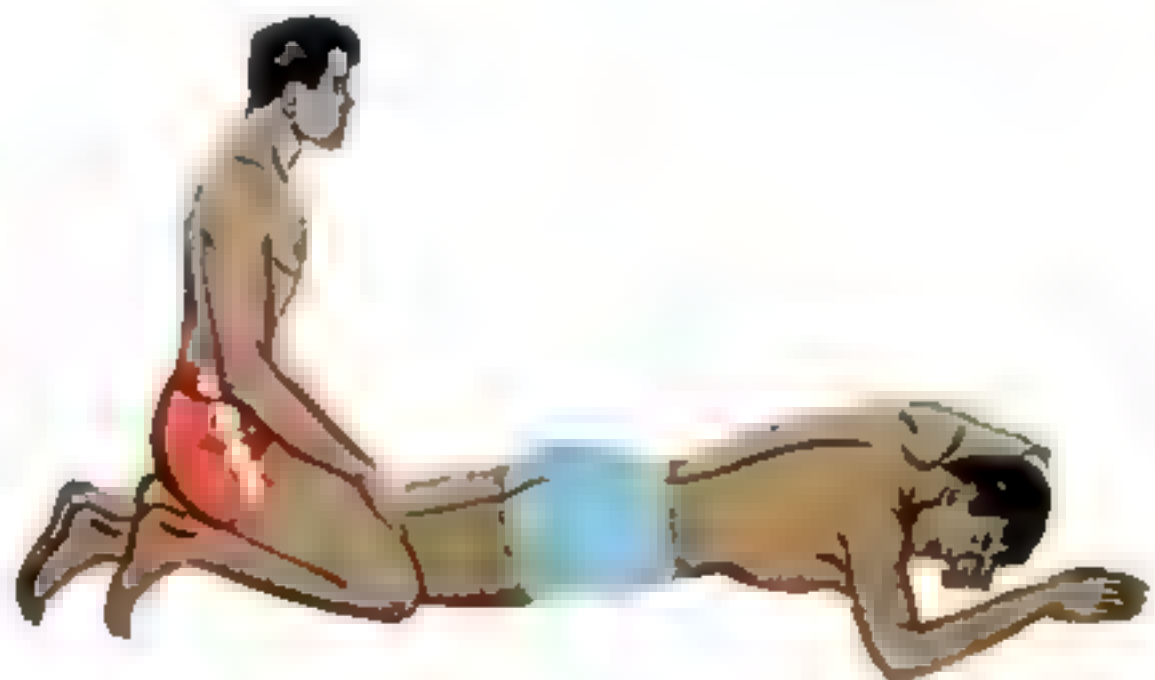
SCHAFER METHOD



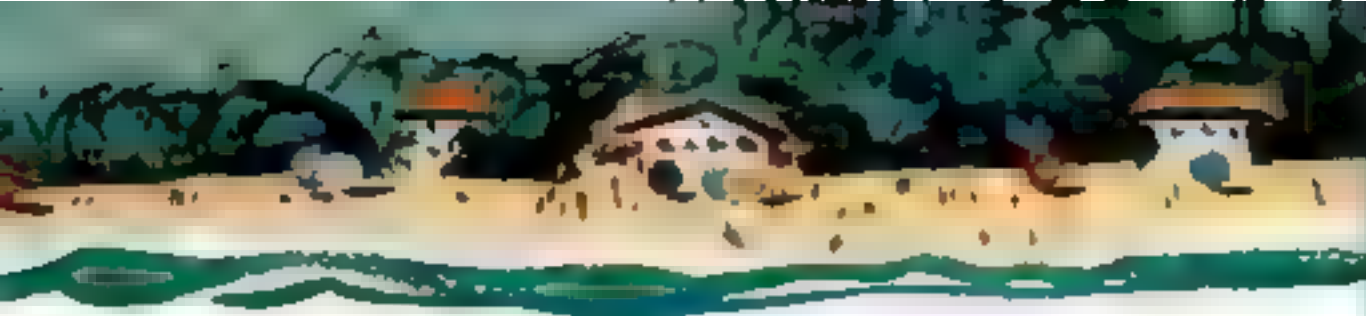
- 1 Kneel straddling the victim's thigh on the side toward which the face is turned. Place palms of hands on the small of the back, with the little finger just touching the lowest rib.



- 2 With arms held straight, swing forward slowly, so that pressure is gradually brought to bear upon the victim. Counting "one-two" your shoulders should be directly above your hands.



- 3 Now, swing backward immediately, so as to remove the pressure completely. After two seconds, swing forward again. Double movement—pressing and letting go—forces out, draws in air.



EVE METHOD

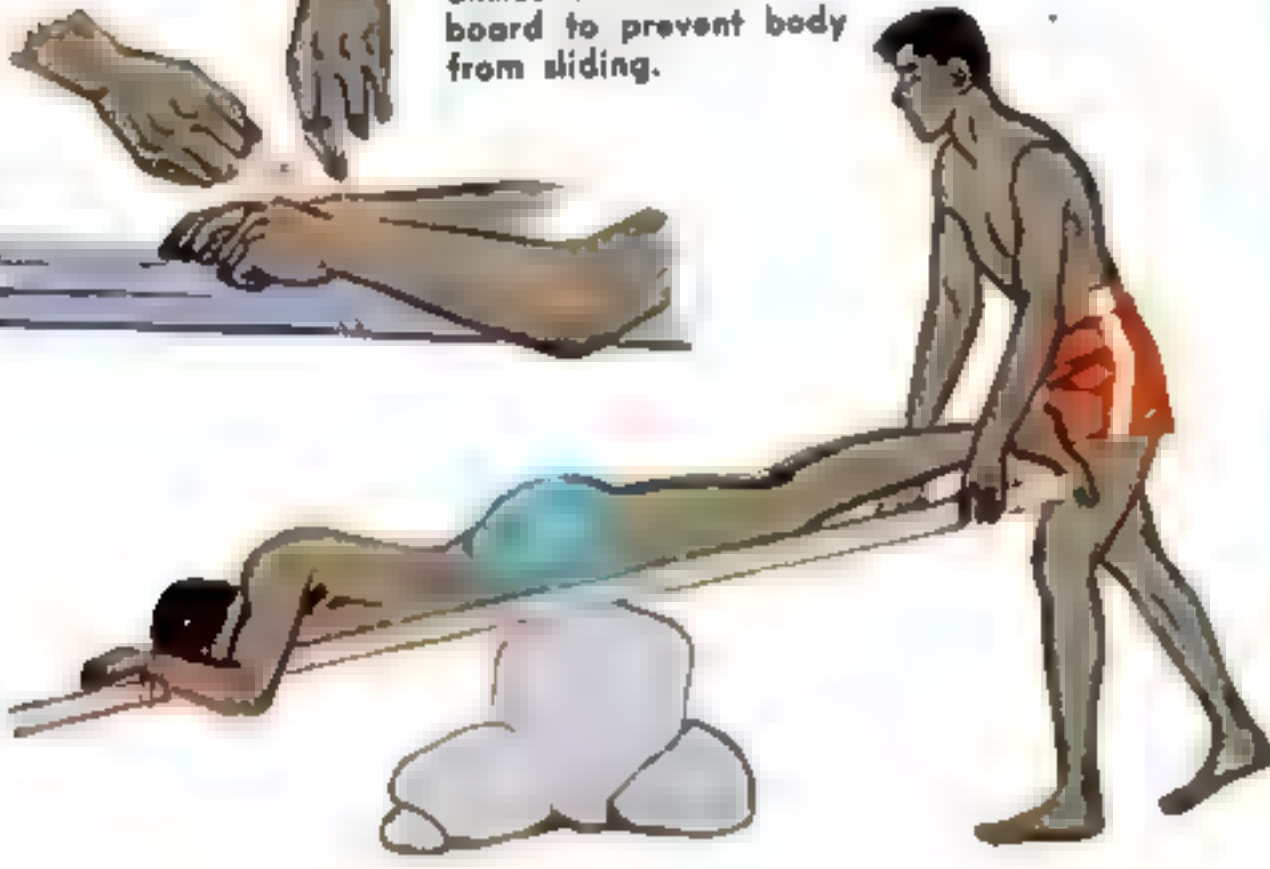


DON'T Swim long distances unless accompanied by a buddy.

1 Make fulcrum for board or stretcher from a few large rocks.



2 Secure wrists and ankles of victims to a board to prevent body from sliding.



DON'T Swim beyond your depth even with artificial support.

3 Lower head to allow water in stomach or windpipe to escape. . . .



DON'T Engage in horseplay in the water.

4 Then rock, 12 to 15 times a minute, until breathing is restored.



DON'T Swim in cold water.

supplying warm blood to the microscopic nerve cells that maintain respiration, as well as ventilation of the lungs. These nerve cells are located where the brain and spinal cord unite. They can be paralyzed by cold and revived by warmth. Dr. Eve states that resuscitation of the drowned is not merely working the bellows of the lungs, but is a fight to revive cold, asphyxiated nerve cells by a circulation of warm blood oxygenated by moving lungs. He believes the future merit of different methods of resuscitation will be judged more by their effects on the circulation than on ventilation, for air in the lungs is often useless unless the oxygenated blood is conveyed to the dying nerve cells.

Much controversy over the comparative merits of the Schafer and Eve methods has taken place. Actually, the methods are complementary in many cases, because the Eve process requires some equipment, which often is not available at the scene. This equipment is very simple and no doubt will become standard at many beaches and pools. But there will occur many instances when the Schafer method, which requires no equipment, should be used at once, and continued until Eve equipment becomes available.

First vital point to remember is speed in administering aid. Surveys show that where more than 15 minutes elapsed between recovery of the victim from the water and beginning of artificial respiration the subject did not survive. **BEGIN ARTIFICIAL RESPIRATION AT ONCE** and continue the treatment for at least four hours, if necessary, or until a physician declares the victim dead. To avoid strain on the heart when the victim revives, he should be kept lying down. A stimulant, such as one teaspoonful of aromatic spirits of ammonia in a little water or a drink of sweetened hot coffee or tea, may be given. *Never give an alcoholic beverage.*

The Eve system is easier on the victim and less tiring on the operator, and requires less

skill than the Schafer method. The British Navy and the U. S. Coast Guard have adopted it as complementary to the Schafer method.

Here is what happens to the body when the two systems are used:

Schafer: Pressure applied presses the abdominal contents (intestines, stomach, etc.) forward into the concave arch of the diaphragm. This bulges upward and compresses the lungs from the bottom upward. Air is expired. When the pressure is released, the ribs spring back into place, the abdominal content slides back, and the diaphragm resumes its natural position. A return flow of new air rushes downward into the lungs under normal pressure of about 15 pounds per square inch. Thus, the lungs are made to function artificially. Coats or blankets are recommended to apply external heat.

Eve: The rocking ventilates the lungs by alternately pushing and pulling the diaphragm up and down. At the same time, blood is forced through the oxygen-starved heart muscle, helping to start it or to restore a feeble beat. Further, the nerve cells of the brain and breathing center receive blood at normal pressure. When the feet-down tilt is made, blood from the extended arms fills the heart and encourages it to beat and pump. Dr. Eve goes beyond the blankets-for-warmth phase, when the equipment is available, in recommending application of hot bottles over the neck to revive the chilled nerve cells at the base of the brain.

Experiments have shown that the Eve method, with a 30-degree rock, produced an average intake of 150 cubic centimeters of air at each inhalation as against 55 c.c.'s under the Schafer method.

The most important thing to remember is that all systems of artificial respiration depend primarily on **PROMPT ACTION**. Any delay may be fatal. As one authority puts it:

"Don't waste time; start squeezing the chest even if you have to use your foot."



Forty-five out of a hundred drowning victims are swimmers who have more ego than ability, and seven times in ten it is a man who needs help. Read—and heed—the warnings of these three experts on safety in swimming:



Jack Goldstein, Chief Lifeguard, Rockaway Beach, N. Y.: "What causes the most trouble? The water. The average person is too cocksure, figures it can't happen to him, so pays no attention to warning signs."



Charles B. Scully, Director, First Aid, Water Safety and Accident Prevention, American Red Cross (N. Y. Chapter): "Use good judgment. If there's a lifeguard around, help him, but let him do the job. It's his business. He knows how."

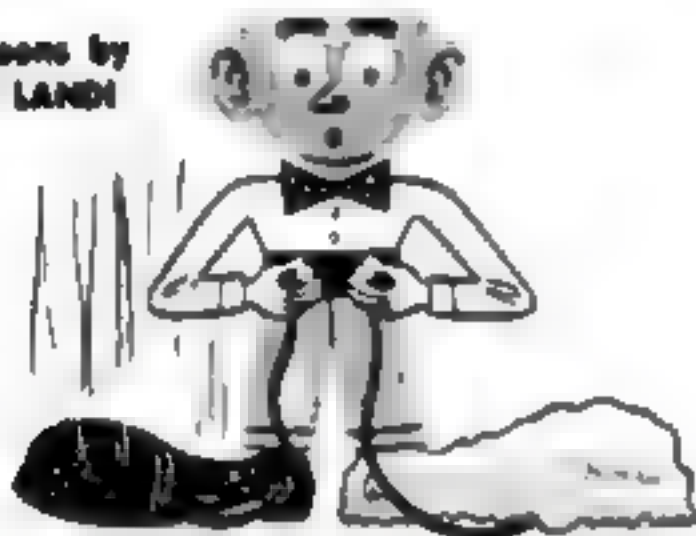


Louis Lipsey, Chief Lifeguard, N. Y. Dept. of Parks, which handles 1,000 rescues a week: "Our greatest concern is not the good swimmer or the non-swimmer. The ones who keep us busy are the poor swimmers. They overestimate their ability."

I'd like to see them make

Everybody has his own pet idea of some gadget he would like to see in general use. What is **YOURS**? *Popular Science Monthly* will pay five dollars for every such suggestion that its editors decide to publish.

Cartoons by
SYD LANDI



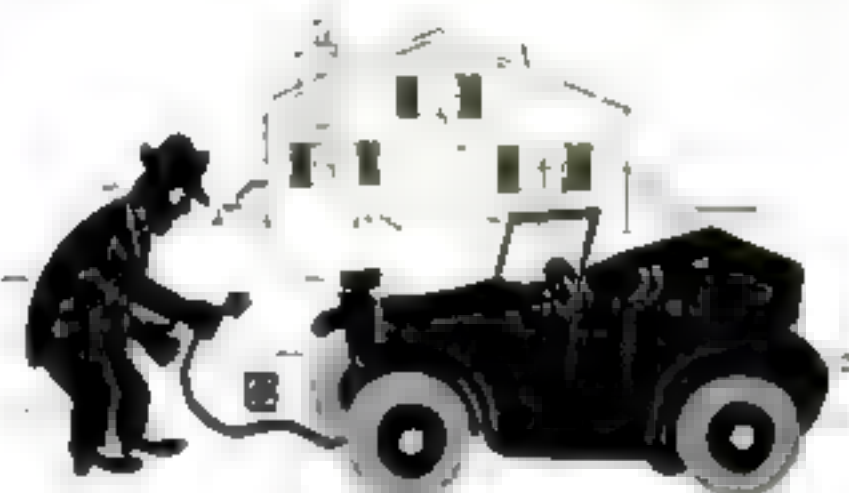
Built-in foot warmers. Current from a heel battery might heat an inner sole, thinks Jimmy Pierce, Greencastle, Ind. Then, we'd never get cold feet, unless. . .



Home-plate "mikes" so bleacher fans can hear the players near the ears of the ump. But how about a censor, Mrs. R. S. Tucker of Fitchburg, Mass.? It's your idea.



Phone bell regulator that would eliminate the clang where only a soft ring is needed but would "pour it on" for grandpop. Suggested by J. J. John, Dayton, Ohio.



Plug-in socket to use house current to start balky motors in winter or those that don't respond to a weak battery. K. J. Miller, Green Bay, Wis., suggests it.



Luminous-inked typewriter ribbons that would allow Skippy McRitchie, Bronxville, N. Y., to type in the dark. Skippy must be at odds with the electric company.



Radar for trucks. With trucks so equipped, thinks Andrew Stelmach, Millville, N. J., drivers would be less likely to back into things—yes, including you and me.



when SUNS explode



Ours seems sturdy, but bursting stars reveal illness of others.

By DONALD H. MENZEL

Professor of Astrophysics, Harvard University

AN EXPLODING star is not news. Dozens of stars blow up each year, increasing their brilliance 10,000 times or more. Most of them, however, are extremely faint before the outburst, and even at peak brightness are not visible to the naked eye. Really bright objects are rare. But when a star bursts twice in a century—that is astronomical news! It gives us significant scientific information about such stars.

In 1866 a "nova" or so-called "new star" flashed out in the constellation *Northern Crown*. It was certainly not a true new star. A distant sun had exploded and greatly increased its output of energy. The brilliance faded rapidly until the star could be seen only with a telescope. When it was about a hundred times too faint to be seen with the naked eye, it stopped fading. It remained a faint star, fluctuating somewhat in brightness, until Feb. 9, when it blew up again. The astronomers call it *T Coronae Borealis*, i.e., *T* (variable star) of the constellation *Northern Crown*.

In 1866 photography was young and pictures of stars were not possible. But we have followed the variations of *T Coronae* ever since. We have studied its characteristics, some of them puzzling. Finding the answer to these might give us more information about the nova phenomenon.

We know little about the "pre-nova" stage. There are so many stars that we cannot hope to pick out for special study

one that may explode some day. The star gives no advance warning of its approaching outburst.

The burst of a nova is a fantastic explosion. The increase in stellar brilliance is as startling as if a firefly suddenly glowed like an arc light! The energy dissipated in a nova explosion is equal to more than that of 100 quintillion atomic bombs. A single bomb, to release that much energy, would have to be almost as large as the earth.

Somewhere in the star vast energy is suddenly released. This energy, struggling to escape, works its way to the surface. The star expands like a soap bubble, all the while increasing in brilliance. Finally, the outer layers are blown entirely away, receding into the distance as filmy wisps of nebulae. Gradually the star subsides to something like its original brilliance. In many novae, some years after the outburst, the fragmentary shell of expanding gas is still dense enough to show up as a nebular ring encircling the star.

The average nova in its final stages appears to be much hotter than it was initially. Observations indicate that the expanding gases around the star may continue to have a temperature of more than 1,000,000° C. for years after the outburst.

Certain astronomers have suggested that the whole phenomenon of novae is due to collapse of the star, and that the energy released in the explosion was produced by compression within. They argue that the nova is a stage in the star's evolution, the outburst marking one last splurge before

it settles down to enjoy a lengthy old age.

The second outburst of *T Coronae*, however, clearly proves that the collapse theory is wrong. It tells us that the tendency of a star to blow up is a sort of disease; some inherent structural weakness causes only certain varieties of stars to become novae.

This conclusion is somewhat heartening to us. It renders the chance of our sun's exploding extremely small. The long record of solar dependability goes back over geological time, more than a billion years. During that interval the sun has never so much as doubled or halved its energy output. The common solar disturbances, such as sun spots or expelled jets of gas, do not indicate that the sun is likely to explode completely, as a few writers have suggested. Perhaps they are "safety valves" that regulate the star, and prevent catastrophe.

There are two other stars that appear to be repeating novae: *RS Ophiuchi* and *T Pyridis*. Neither of these is as clear-cut a case as our recent example. The indications are that *T Coronae*—before the explosion—may have had an extremely bloated and fairly cool atmosphere surrounding a very hot and tiny core. During the outburst, this surrounding gas is blown out with other material. Thus the star (the minute core) is indeed much smaller after the explosion than before, as the observations demand, but there is no collapse.

The star probably explodes in jets, rather than uniformly all over the surface. The inner regions are so hot that the color of light has a distinct violet hue and the ultra-violet radiation is extremely intense. Along the jets the color changes from violet to blue to dazzling white. There may be a slight tinge of pink on the outer edges of the puffs, where the temperature is lowest. Between successive outbursts, *T Coronae* succeeded in at least partially rebuilding the bloated atmosphere, for the color displayed was often very red.

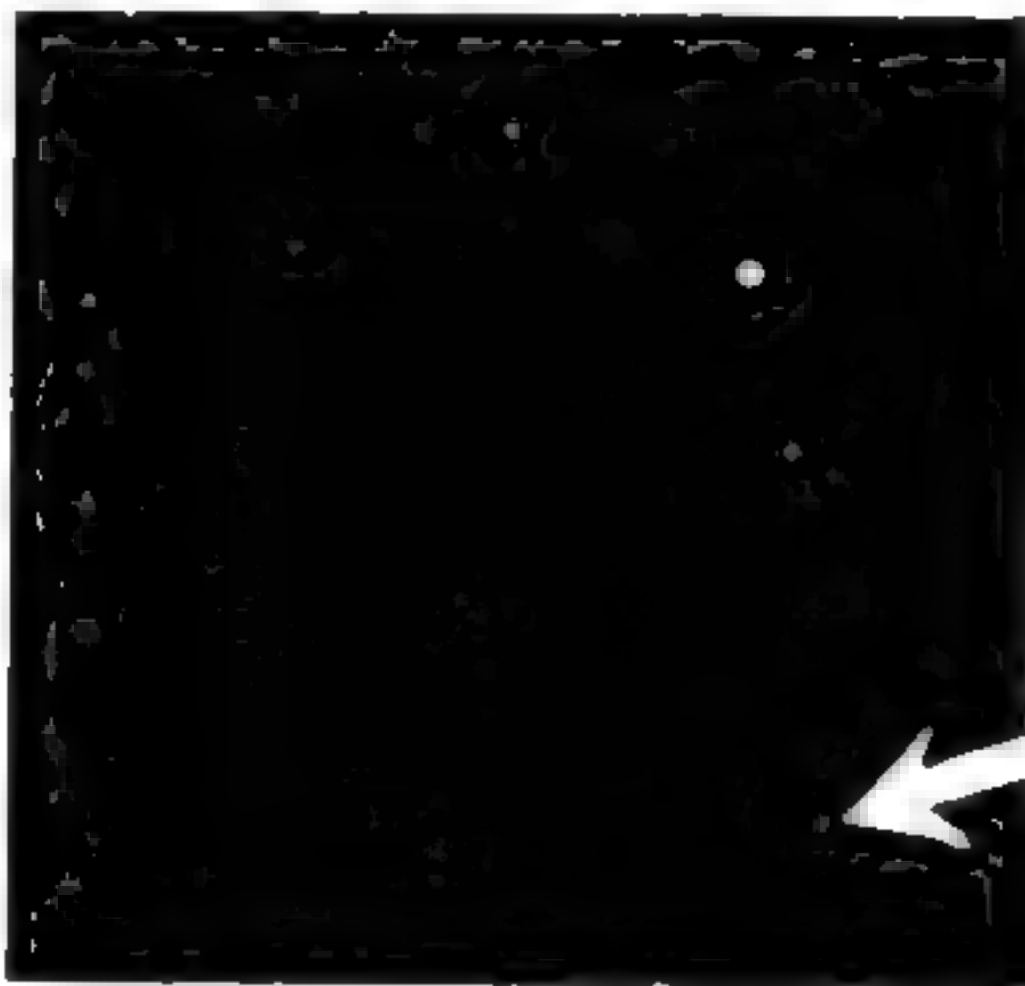
A nova outburst does not seem to be a major catastrophe in the life of the star. In most cases the star recovers and may prepare for another relapse in the near—or distant—future. Even a few thousand years is a short time in the life history of a star.

Most new stars have exploded only once within the memory of man. But it is quite possible that some of these may burst again.

The most famous of all novae is Tycho's star, which outshone all but the planet Venus, in the year 1572. There were no telescopes then, and we do not know which of several faint stars in the vicinity may be the one Tycho observed. This outburst was so great that astronomers call it a

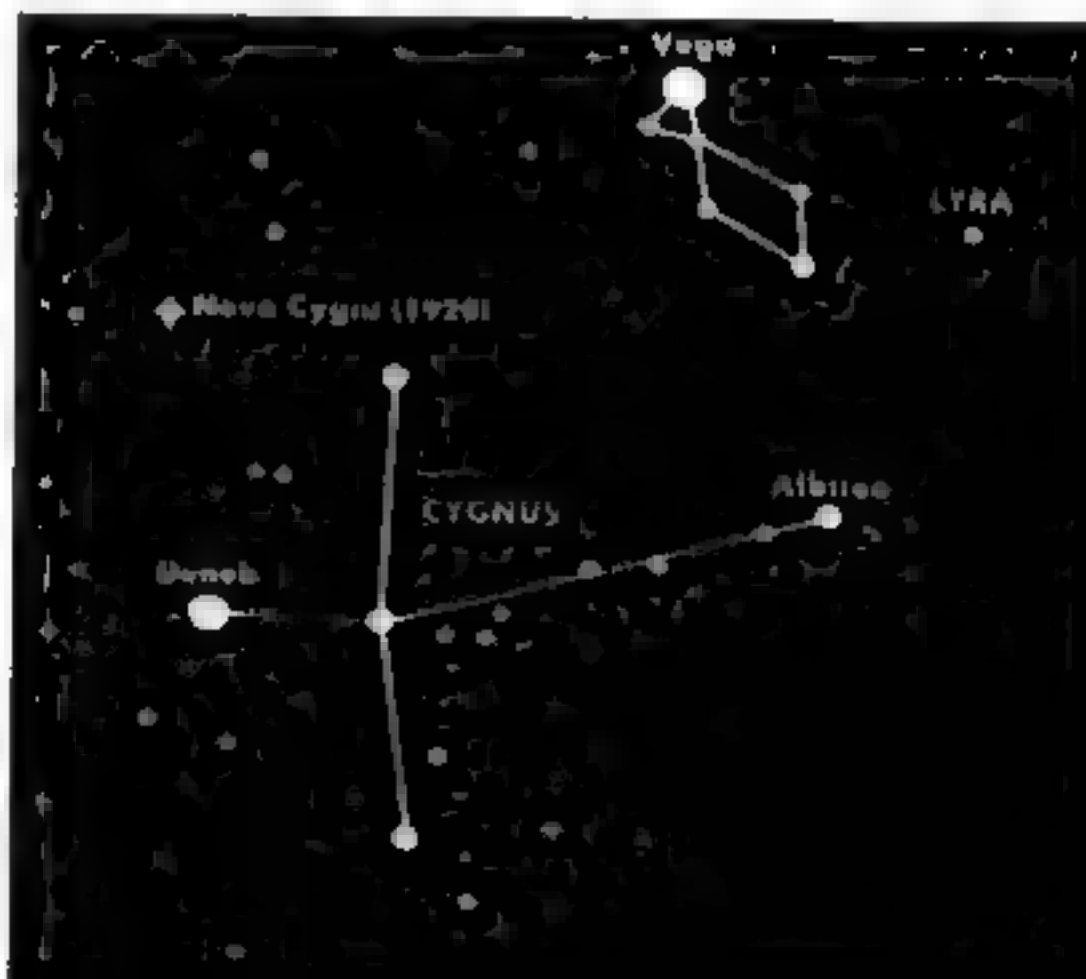
supernova—a very rare phenomenon indeed. The explosion may have wrecked the star completely, so that we may not have a recurrence. But astronomers still watch, hopeful of seeing it again.

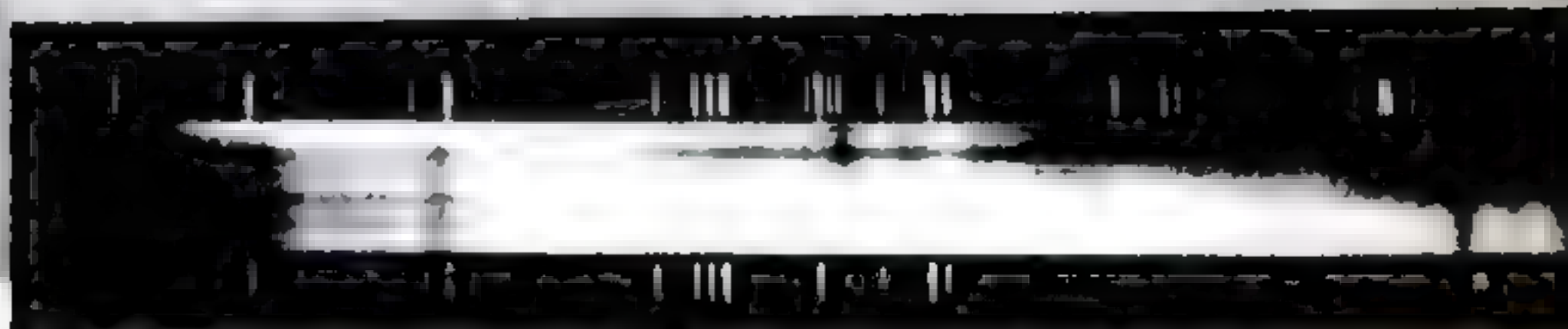
A variable star in *Andromeda*, *Z Andromedae*, shows signs of novalike activity and



some day may flare into brilliance. Watch these places in the sky and you may some day see an unaccustomed star there. If you should see a nova, notify the nearest astronomical observatory by telegraph, as soon as you have checked that it is not just a planet. Those familiar with the sky can do a real service to astronomy and science by watching for and reporting new stars.

When one of these objects appears, astronomers all over the world train their telescopes upon it and take photographs and spectra (rainbow colors) in rapid succession.





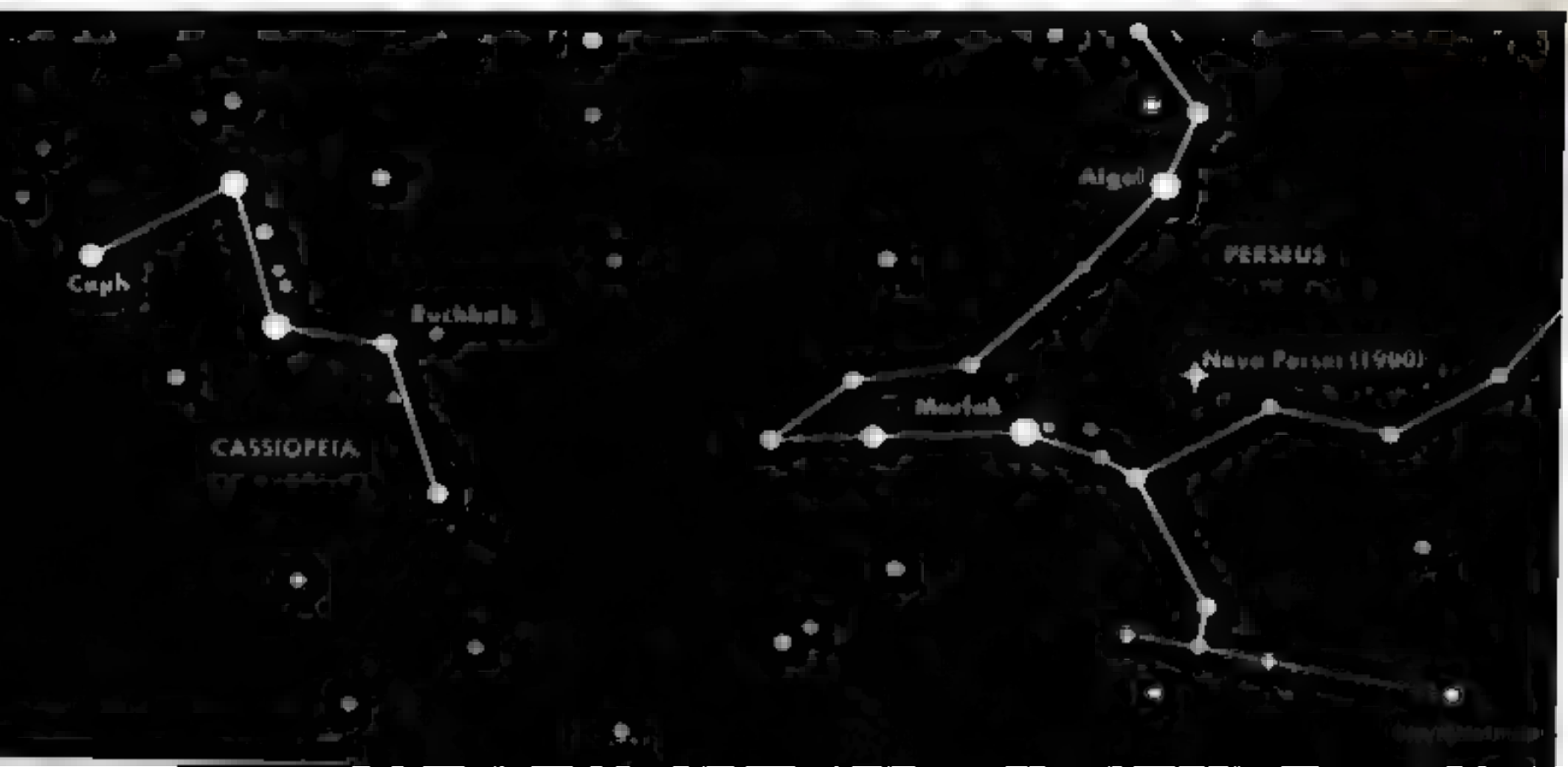
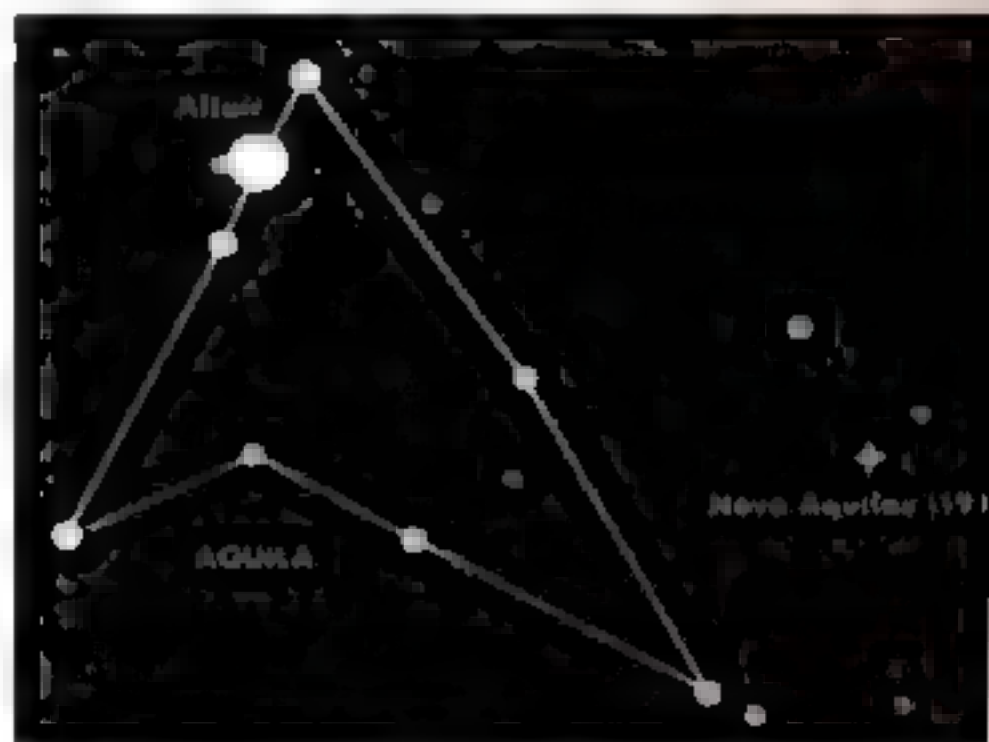
The earlier stages are particularly important because we know least about them, and because the changes are most rapid.

The energy source of these tremendous explosions may well be some sort of nuclear reaction, different from, but none the less akin to, those in the atomic bomb. In ordinary stars the release of atomic energy appears to be well controlled, but in the novae the processes appear to get out of hand and the tremendous bursts occur.

Theoretical and observational studies of these atom-star-bombs are important for scientific advance. The knowledge gained of gases at high temperature, the behavior of tremendous explosions and the conditions giving rise to them, may contribute to the problem of atomic power. It will certainly help us to understand a star's constitution.

Most novae appear in the part of the sky where the constellations *Cygnus* (at left, below), *Perseus* and *Cassiopeia* (below), and *Aquila* (right) lie in the Milky Way. These sky maps show what the constellations look like and where and when several novae have flashed out in recent years.

To the naked eye, *T Coronae Borealis* (at arrow point, left), even at its maximum brilliance, was a modest, slightly askew jewel in the constellation *Northern Crown*. Through the huge telescope at Yerkes Observatory, however, it really looked like an exploding star (above). The spectrum below the photo shows the broad band produced by hydrogen atoms traveling 2,500 miles a second.



Jet propulsion is fifth use for captured exhaust gases.

WASTE now makes haste. Engineers have added up to 28 miles an hour to airplane speeds by narrowing the size of the tubes that carry exhaust gases into the air. This is the latest and fifth—way of putting to work the vast energy that is lost when gasoline is burned in a cylinder.

An airplane engine is only about 30 per cent efficient. An engine of 3,000 horsepower throws away 7,000 horsepower in waste products. "exhaust solids," such as carbon, and plain heat. For years most of this heat—precious energy—was spewed out of exhaust stacks into the atmosphere. Today, however, aircraft and engine manufacturers collect the hot exhaust gases in an engine's metal manifold harness and use them to make flying simpler, safer and faster.

There are four ways, other than for supplemental jet propulsion, in which waste is put to work in the air:

In the turbosupercharger. This is the "iron lung" that crams compressed air into engine cylinders to feed the fires of combustion. Mechanical superchargers drain away power. The vaned turbine of

the exhaust-driven supercharger does not. Driven at 30,000 revolutions a minute, as a mill wheel is turned by a stream, it turns a compressor that packs air into the engine.

As an anti-icer. Under certain moisture conditions at high altitudes, ice forms on the leading edges of wings and tail surfaces. It adds weight and distorts the shape of wings and tails until they lose part of their lift. For years large aircraft have been fitted with rubber, pulsating "boots" to break off ice after it forms. By putting waste exhaust gases to work, ice formation can be prevented altogether. Hot gases are piped to a "heat exchanger," where they give up their heat to a flow of air. The heated air is piped to surfaces susceptible to icing. No toxic gases or exhaust solids are carried to such surfaces to erode the metal.

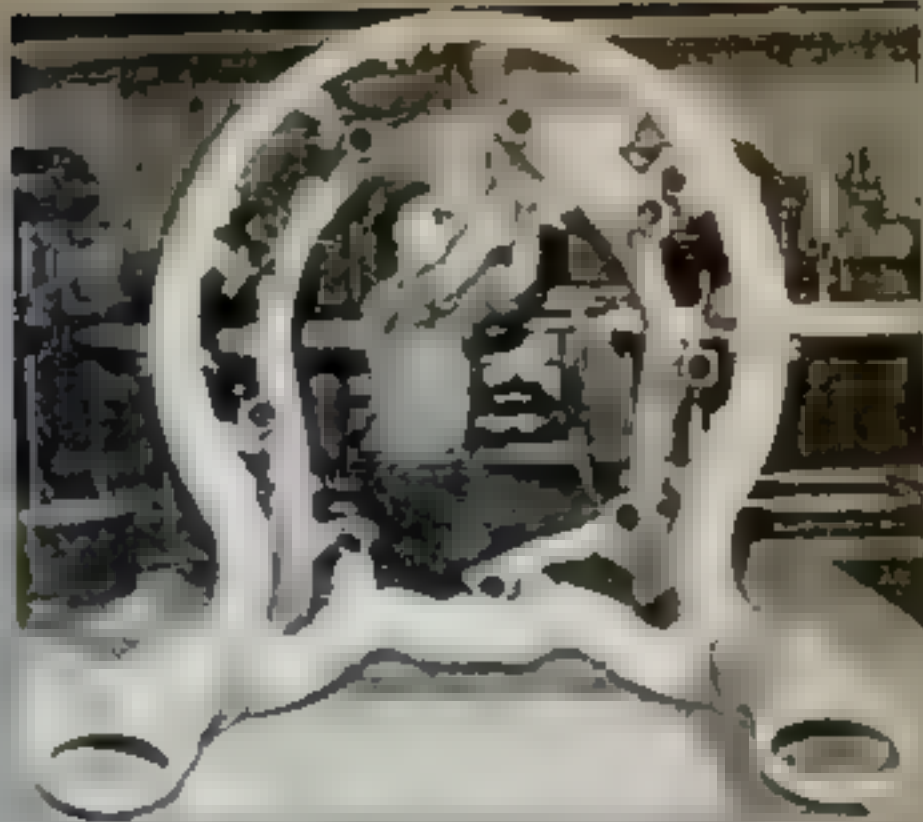
For cabin heating. It's often cold in a plane aloft even when it's hot on the ground. Other heat exchangers warm the air that flows through cabin and cockpit.

For carburetor heating. Carburetion absorbs heat. If freezing air enters the carburetor meanwhile, ice can collect on the air screens and clog the "breathing" process. To keep the carburetor warm and iceless, exhaust gases are piped through a heat exchanger into the engine assembly

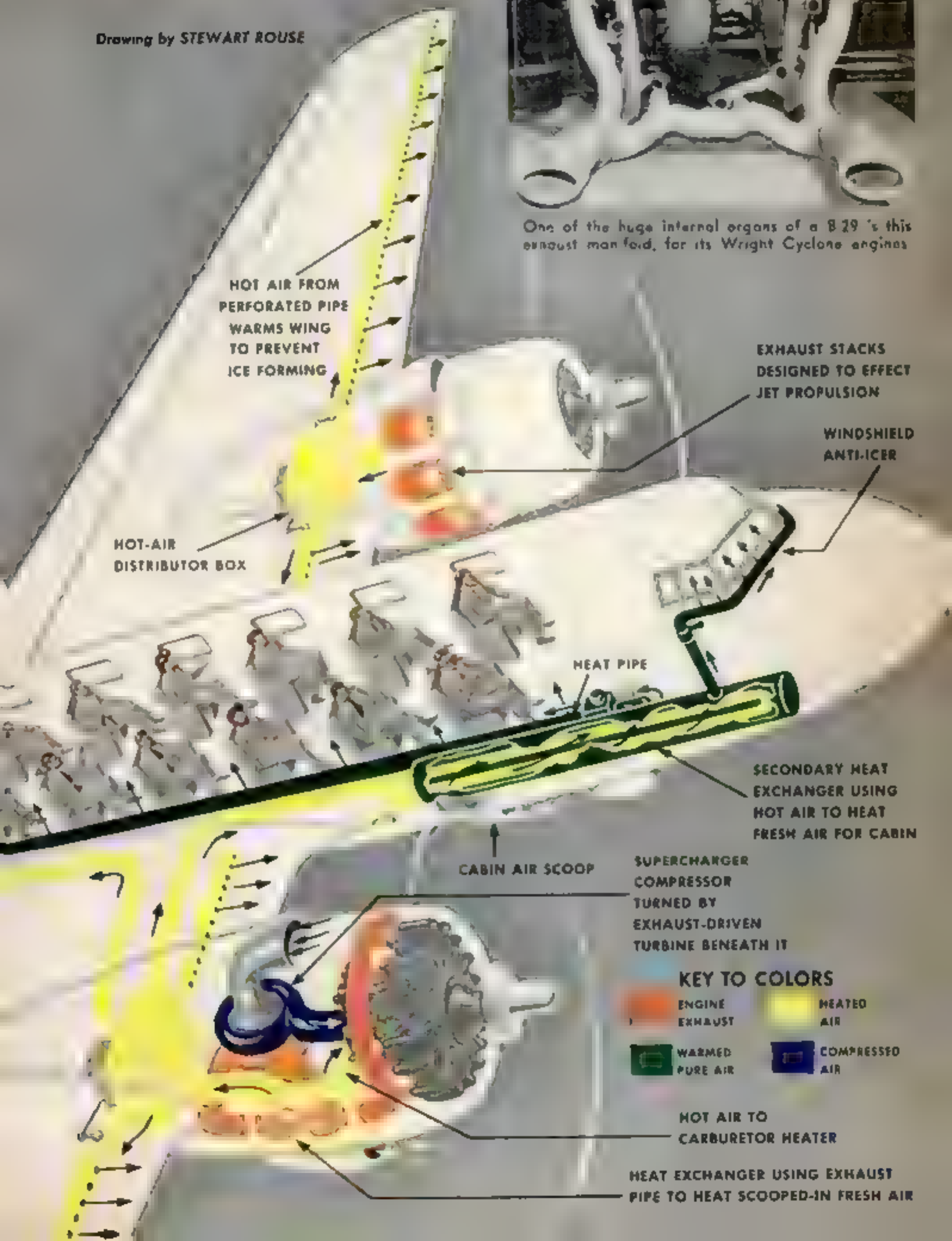


An airplane's exhaust system does much the same work as an automobile's, except that it must handle hotter gases in much greater volume. Pioneer research work in stainless steel to produce exhaust manifold harness that will stand up under temperature ranges of -65° to $1,700^{\circ}$ F. has been done by Ryan Aeronautical Co., of San Diego.

Drawing by STEWART ROUSE



One of the huge internal organs of a B 29 is this exhaust manifold, for its Wright Cyclone engines



GOLD Lures Miners to record depth



THE LONGEST elevator ride in North America is in a gold mine. Hoists in the fabulous Lake Shore Gold Mine at Kirkland Lake, Ontario, Canada, drop workers to their assigned working levels at the rate of 2,000 feet (200 stories) per minute. The vertical shafts are almost eight times as deep as the Empire State Building is tall. Now the deepest hole on this continent—6,884 feet below the surface—and one of the world's richest mines since 1912, Lake Shore is being sunk another 500 feet this year, and plans call for an even deeper penetration at a later date.

More than 12,000,000 tons of rock have been blasted and hauled out to form the 100-mile labyrinth of Lake Shore's drifts and crosscuts that runs under Kirkland Lake's streets and surrounding countryside.

There are 46 levels in the mine, spaced from 150 to 250 feet below one another, and each level is a community in itself

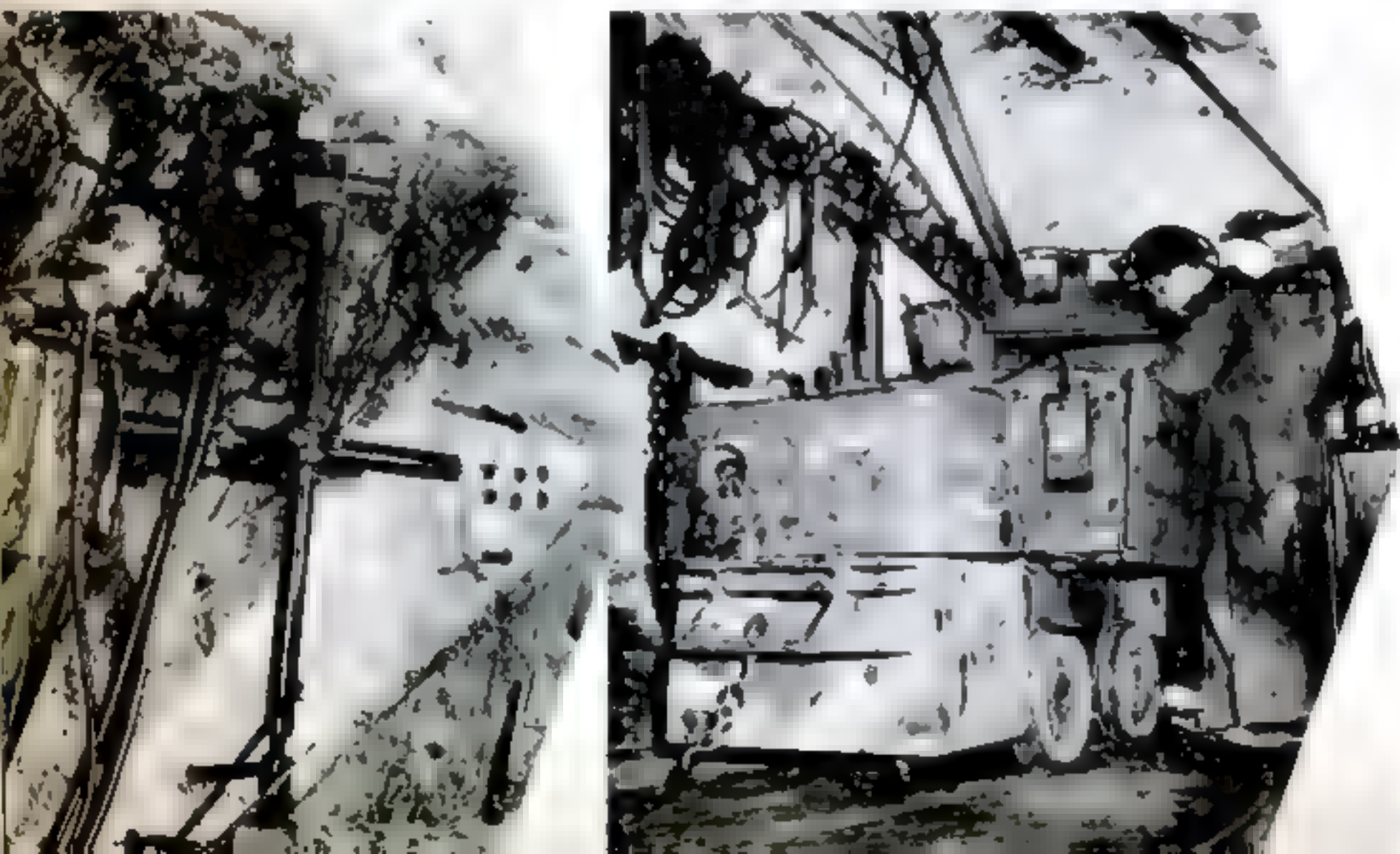
with its own railroad, giant generators, pumps, repair shops, underground offices, and population of workers who follow the elusive veins of precious metal through the hard rock.

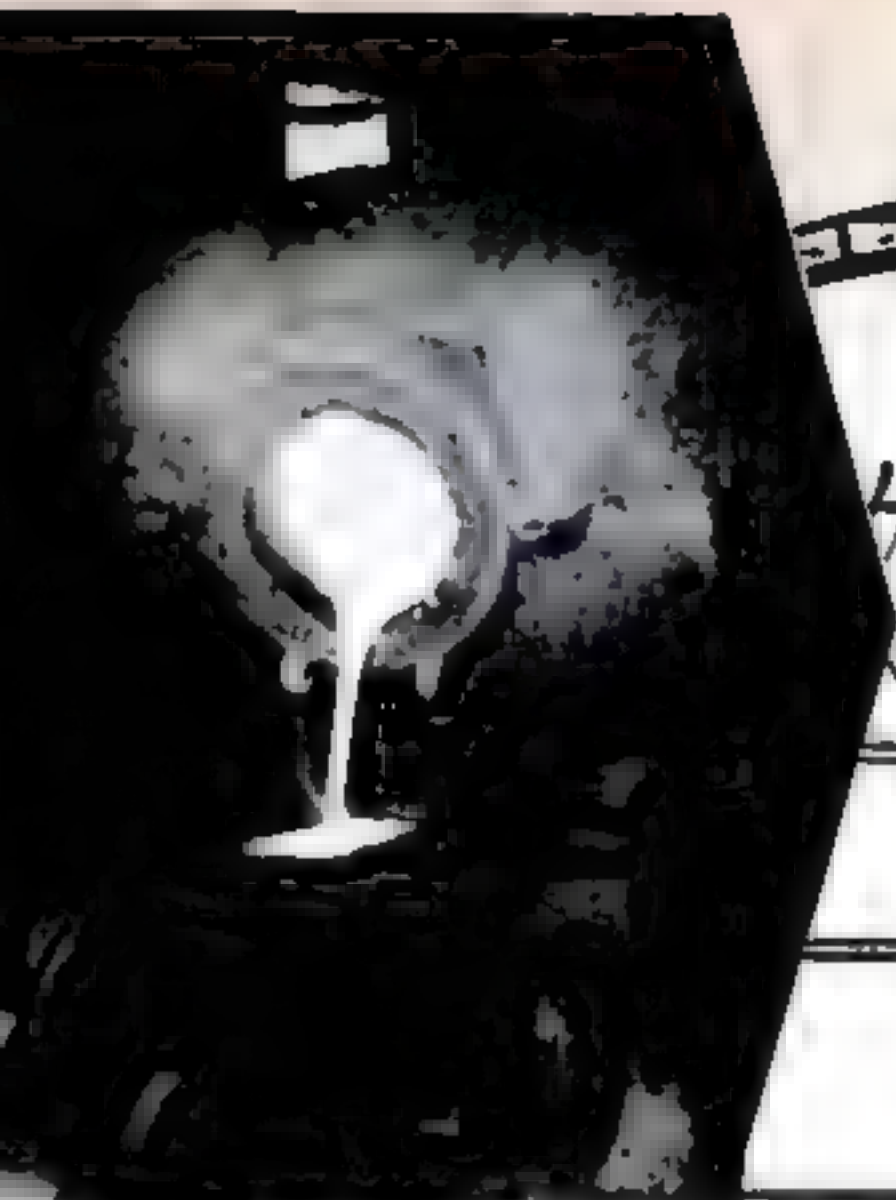
Strangely, no matter what the temperature at the surface, it is always 87½ degrees at the 6,800-foot level. Throughout the rest of the mine, ventilation keeps the temperature at 72 degrees all year round.

Harry Oakes, later knighted, whose murder in Nassau, the Bahamas, was a sensation in 1943, made the original strike at Lake Shore after being put off a train for not paying his fare within a few miles from where the famous strike was made. Since that day in 1912 vein after vein has been discovered; \$198,000,000 in gold has been taken from the mine, and the \$98,000,000 paid in dividends has been the source of several famous fortunes in Canada and the United States.

Drilling into a gold-bearing quartz vein over a mile underground, preparing to blast out ore at Lake Shore. White quartz yields high-grade metal.

This worker is repairing an electric locomotive 4,700 feet underground. Each of the 46 levels of the fabulous Ontario mine has its own railroad, shops, and roundhouse.



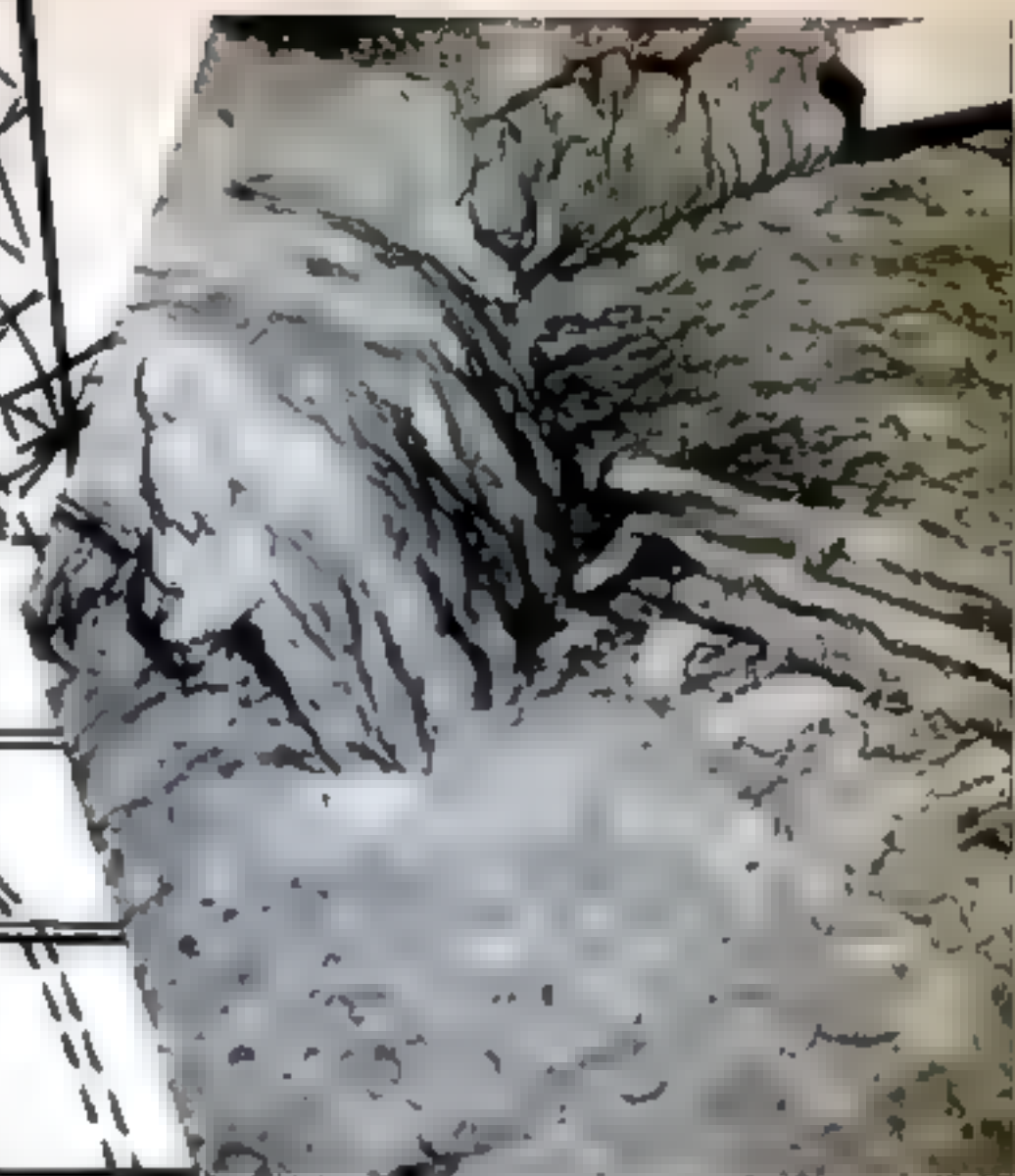


In the bullion room on the surface, pure gold is poured into 25- and 150-pound bricks, then shipped to the mint at Ottawa.

Ore, chuted from upper levels and hoisted from lower ones, is crushed here before going to the mine mill on the surface.



SURFACE LEVEL



This sludge of finer-than-talcum rock and water is flowing toward a cyanide solution that separates the gold from the rock particles.



ORE-CRUSHING LEVEL - 3,825 FT.

A 300-foot endless conveyor belt carries ground ore from the crushers to the hoists that will lift it to the surface for grinding into powder.

DEEPEST WORKING LEVEL - 6,884 FT.



Wheel Weaves **COLORS** Together for Television

Dr. Peter C. Goldmark, head of CBS engineering research and development, inspects a color wheel. Improvements in filters since 1941 have helped to reduce flickering. Sponsors declare this wheel reproduces colors more truly than films do.

COLOR television for which the Columbia Broadcasting System has gone to bat began last winter with transmission of movies, direct transmission of street scenes by means of a live color television camera is promised this summer.

Actually, persons gathered around a Columbia ultra-high-frequency television receiver are seeing an extremely rapid series of one-color pictures—first red, then blue, then green. The pictures are seen through a rapidly revolving color filter, which is mounted in front of the set's viewing tube, and the persistence of vision within the watcher's eyes causes the

images to appear in their natural colors.

The color television image is produced by modulating a 10-megacycle video band, wider than in prewar tests (PSM, July '41, p. 63), and is composed of 525 lines of red, 525 lines of blue, and 525 lines of green. They are transmitted in that order, but a complete three-color frame is received in 1/20 of a second.

Whatever the color television camera picks up is reproduced in exactly the same way. If a black and white newsreel were to follow a studio program in color, it would not be necessary to change the dial setting on the receiver.

This receiver enlarges pictures on a 10-inch tube to 12 inches in diameter. Early television pictures were limited to about two by three inches. CBS color television permits images of any size.

Photographed as it appeared on a receiver's screen, this image has been enlarged to 21 inches in diameter from the face of a five-inch tube. Radio and video-frequency components are the same as in set-off.





Chief Fife illustrates (bottom photo) how smoke from a basement fire travels up the stairway to the first floor; how (middle photo) quickly shutting off the second floor limits smoke damage; and, with his model pumper, how a fireman puts out the blaze, once proper ventilation is provided.

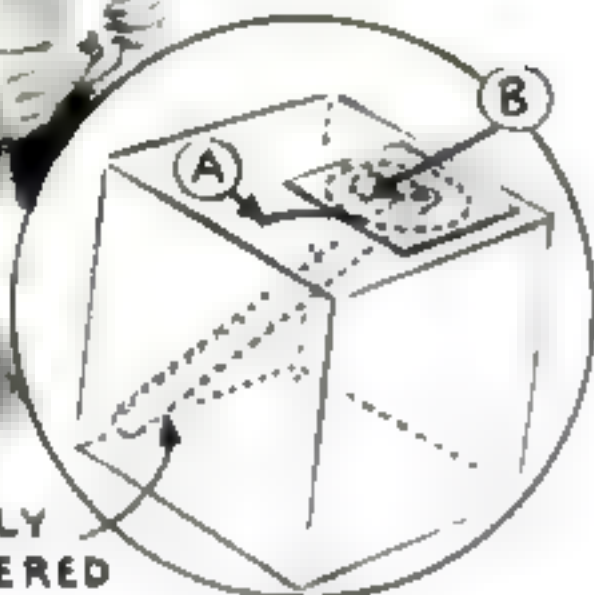
Firemen's Models Teach Tactics

NEARLY 7,000 Americans die each year in home fires—more than twice as many as die in fires that occur elsewhere. Why shouldn't the average home be at least as safe as an ammunition plant, the second safest place in American industry? Thad Fife, chief of the Western Cartridge Company's fire department at East Alton, Ill., thinks it can be.

Fife, who has been instructor of fire fighting at four state universities, says that the same principles of ventilation used in fighting factory fires will locate and lead to the prompt extinguishing of fires in houses. He uses a model house and toysize fire engine to show how his ideas work.

Although a fire may be confined to the basement of a house, the smoke and gases may fill the first floor above, hiding the fire's real location, Fife explains. But immediate ventilation disperses the smoke and reveals its source, so that firemen can put out the blaze with water or chemicals. The proper way to ventilate a basement fire, Fife says, is to open a basement window to windward, then a first-floor window on the opposite side of the house.

NEW IDEAS



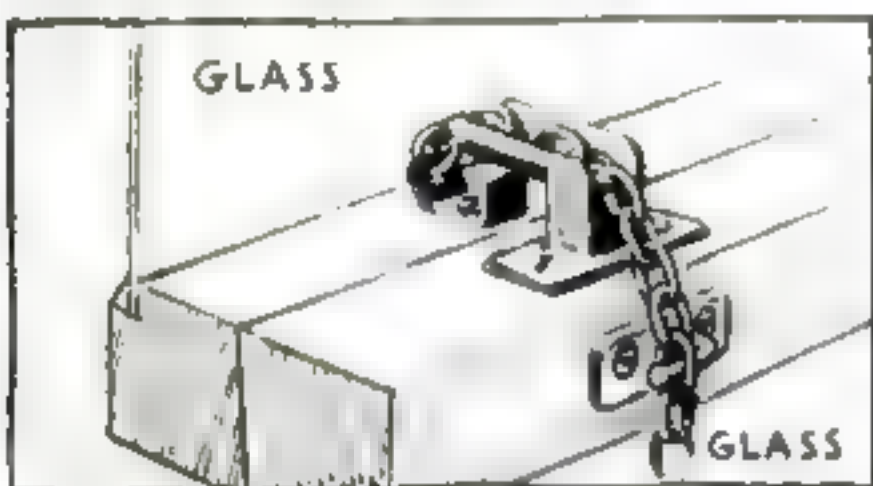
TUBE
SLIGHTLY
TAPERED

Drink Carries Its Own Straw.

Presumably at some time the victim of a milk or soft-drink container that burped on his vest, Louis J. Humbert, of Wyandotte, Mich., has designed one that carries its own straw. The proposed container would be of waterproof cardboard and any desired shape. The straw is to be built-in and have an inner tube, which can be pulled out to drinking length. A string (A) attached to the outer seal opens the container. Another string (B), attached to a cork in the inner tube, hauls that tube out and, with an extra tug, uncorks the drink.

Locks Window Open or Shut.

A chain lock invented by Tolbert Hannon, of San Francisco, would firmly fasten a window shut or partly open. The chain, attached to the bottom sash of the window's upper half, is to run through a metal guide on the top sash of the lower half of the window and be fastened, by any link, to a metal hook on the front of that sash.

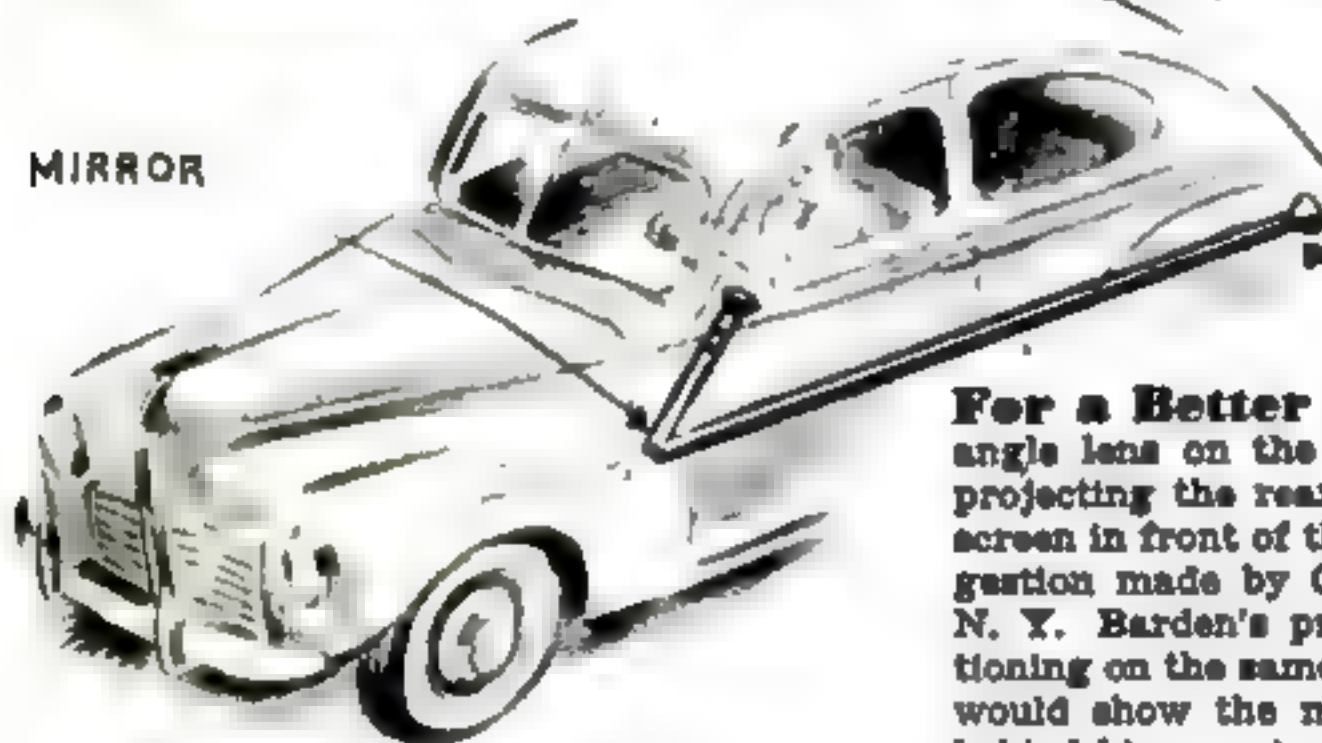


SNAP
BUTTONS



Fresh Cuffs Snapped On. From Jean Persin in Paris, where the detachable cuff apparently is still in vogue, comes a suggestion to snap on a fresh pair when the old ones become soiled. Snap-button bands would be sewed onto reinforced tapes.

MIRROR

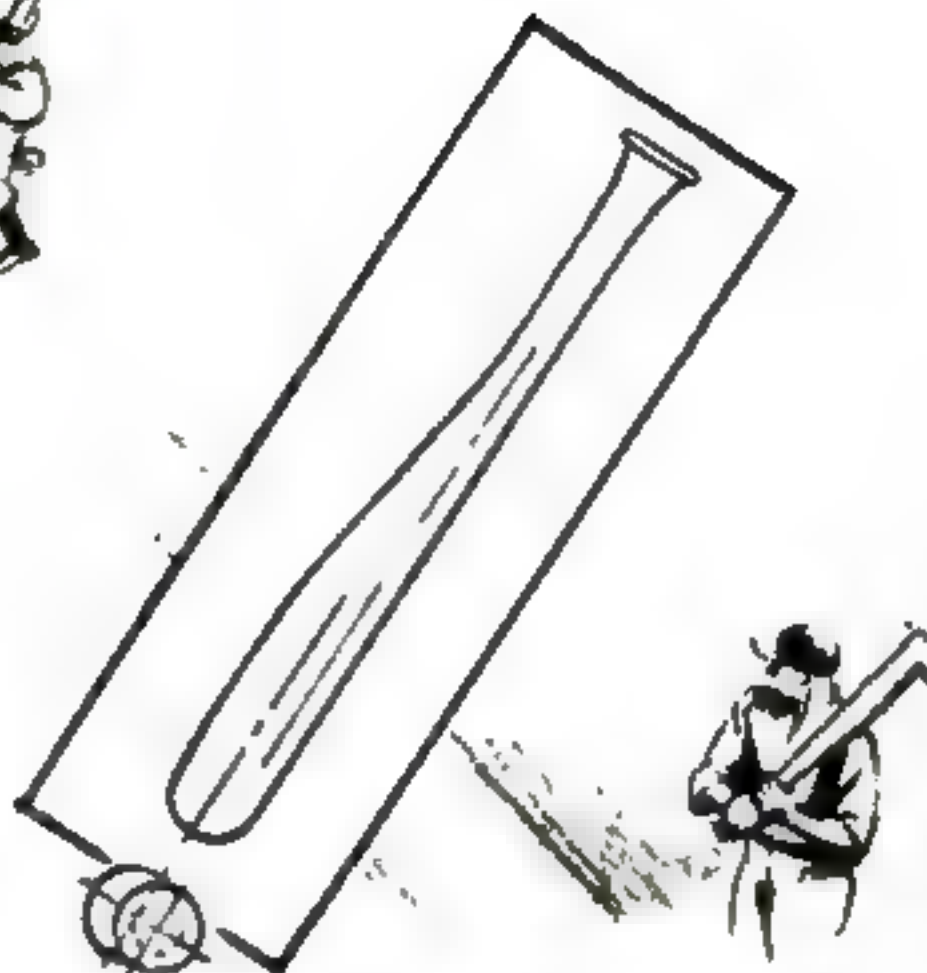


WIDE-ANGLE
LENS

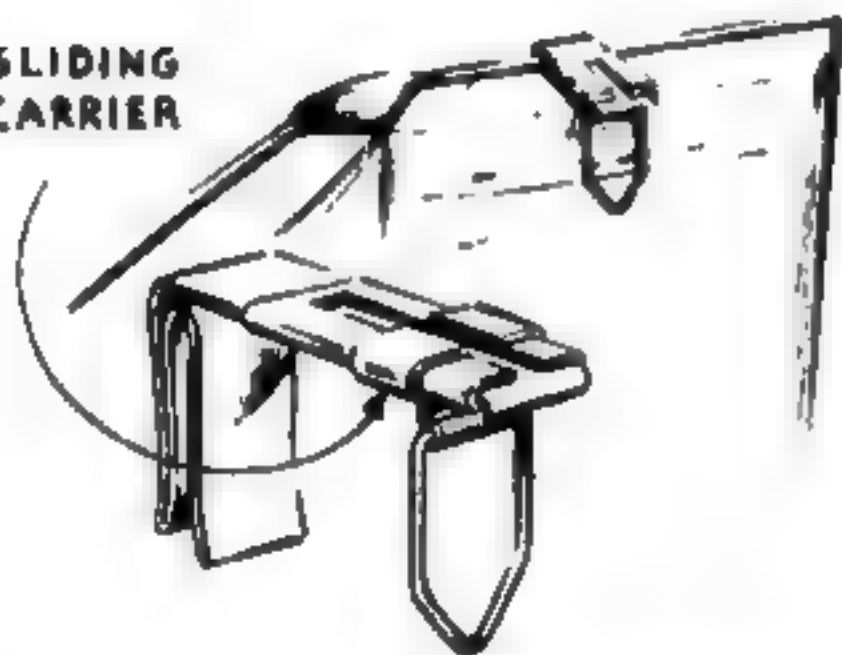
For a Better Rear View. A wide-angle lens on the back of an automobile, projecting the rear view to a ground-glass screen in front of the driver, is a safety suggestion made by Clifford Barden, of Lisle, N. Y. Barden's proposed apparatus, functioning on the same principle as a periscope, would show the motorist what is directly behind his car at a level below the range of the usual rearview mirror. This would help in parking and backing.

FROM THE INVENTORS


Bat with a Bulge. A lopsided baseball bat has been designed by Samuel Janis, of Baltimore, who maintains that it will knock the horsehide right out of the park and take some of the sting out of connecting with a fast one. Because Janis's bat has one center of gravity for the handle and a parallel one for the hitting end, it will swing more easily, the inventor argues. He adds, in the restrained language of patent claims, that the bat will "create unusual reactions, confusing to other players." One reaction it is interesting to speculate upon is that of the Rules Committee of the major leagues.



SLIDING CARRIER

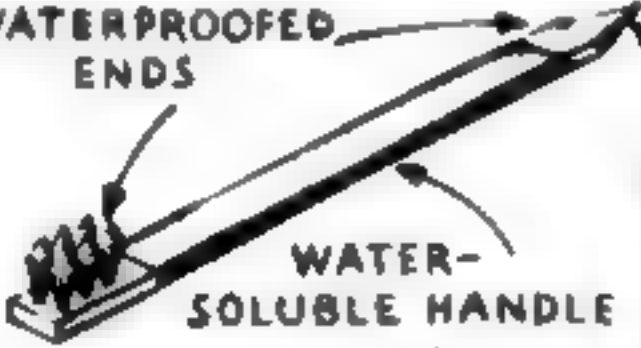


Nonelusive Bookmark. For the relief of avid readers who must waste precious time, whenever they return to an engrossing book, hunting for the torn corner of envelope or fragment of newspaper with which they confidently thought they had marked their place, Alex Pascoo, of New York City, suggests a new kind of bookmark. Pascoo's device clamps to the back cover of a book. The marker is to be hinged, to permit pages to be turned, and move on a slide so that the slack can be taken up as the reader nears the end of the story.



PAPER

SOAP




WATERPROOFED ENDS

TOOTH PICK

WATER-SOLUBLE HANDLE

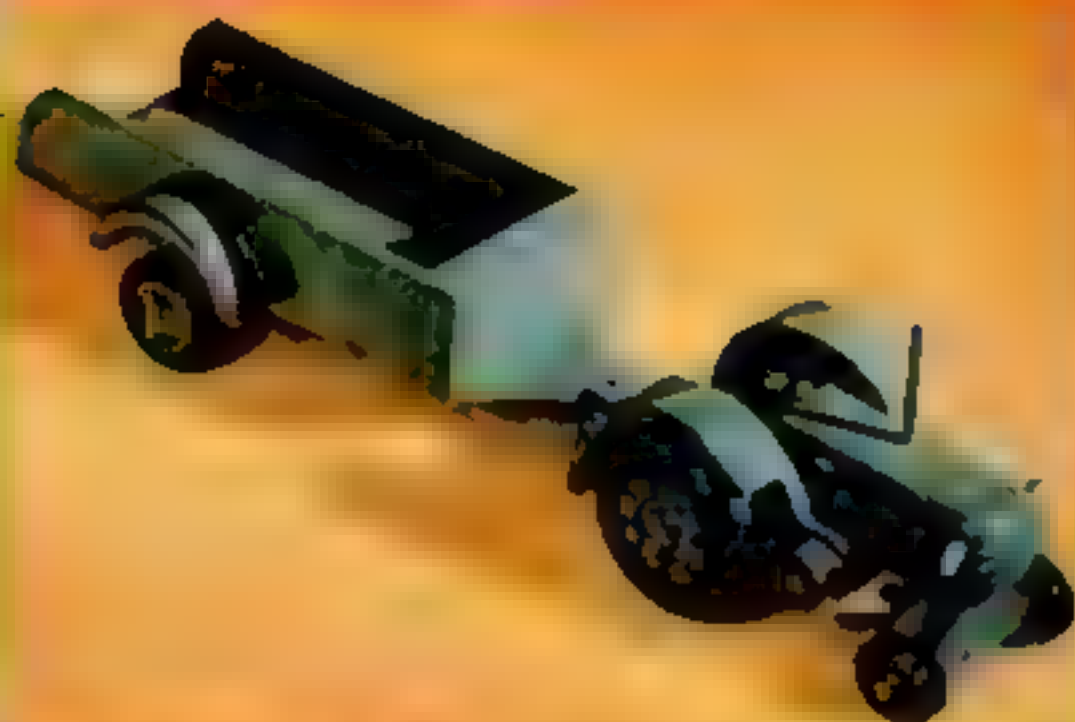
Travelers' Aids. Soaped tissues that can be used to clean the hands and face but dissolve in the washing-up process are an idea of James H. Mulise, Bridgeport, Conn., inventor, for making travel more sanitary and traveling bags lighter. Another proposal with the same purpose is that of Byron A. Babel, Highland, Calif., who suggests a toothbrush with a handle that will dissolve in water after it has been used. Its pointed end will serve for a toothpick. This brush would also have bristles impregnated with a dentifrice, thereby saving more room in the traveler's toilet kit.



Launched on a towline, the glider shown here has made flights up to 4 min., 20 sec., aided by a thermal. How to build one of balsa is detailed on page 162.

CRAFTWORK

PROJECTS OF THE MONTH



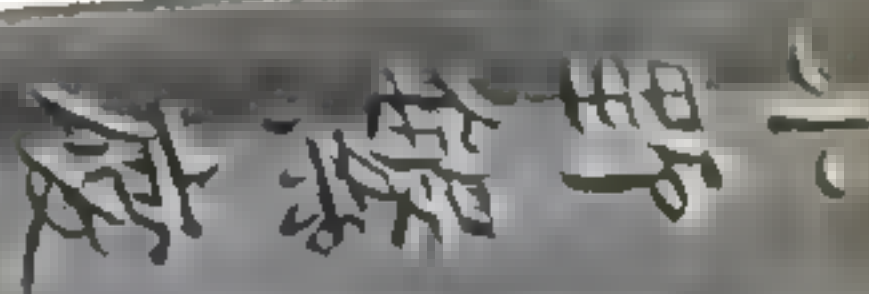
The toy tractor and farm trailer at left are all-wood projects made from scrap stock. Turn to page 156 for construction steps.

Housing problems may not be solved with a couch like the one below, but once a small home is found, it turns a living room into a bedroom and provides storage behind and under springs. Plans on page 146.





some JAP SWORDS are good



GIs brought back many kinds;
here's how to tell the best.

By DAN OTA

IN PREWAR Japan a foreigner found it easier to purchase a rare gem than a genuine antique *Nippon-to*, traditional two-handed sword. For the past 40 years, especially, it had symbolized intense Japanese nationalism. Today thousands of these swords have been brought to the United States by veterans from the Pacific. But only a few of the new owners know that their souvenirs were once bought and sold for prices up to \$10,000 apiece.

Before V-J Day, the demand for *Nippon-to* came from private collectors, museums, and Japanese army and navy officers. The military market boomed as Jap conquests multiplied. Since the supply of antique *Nippon-to* was limited, consisting largely of family heirlooms, prices soared 1,500 percent between 1930 and 1940. But Japan's defeat, its devastating effect on the popularity of militarism in Japan, the Allied confiscation of swords as a part of disarmament, and the transfer of the swords into uncritical hands dropped the prices to junk-

A Jap sword's pedigree, its maker's name, is usually forged into the hilt—as is Shigeyoshi Ono's above. To uncover this, the safest procedure is first to tap the bamboo peg out of the handle (top left); then to loosen the blade by holding the sword, point upward, in the left hand and striking the left forearm with the right hand; and finally to lay the sword on a table (top right) and slide the hilt off. Decoration at left is an ancient sword guard.

store levels. Values flared only when GIs, eager for fancy souvenirs though unaware of their former costs, bid them up.

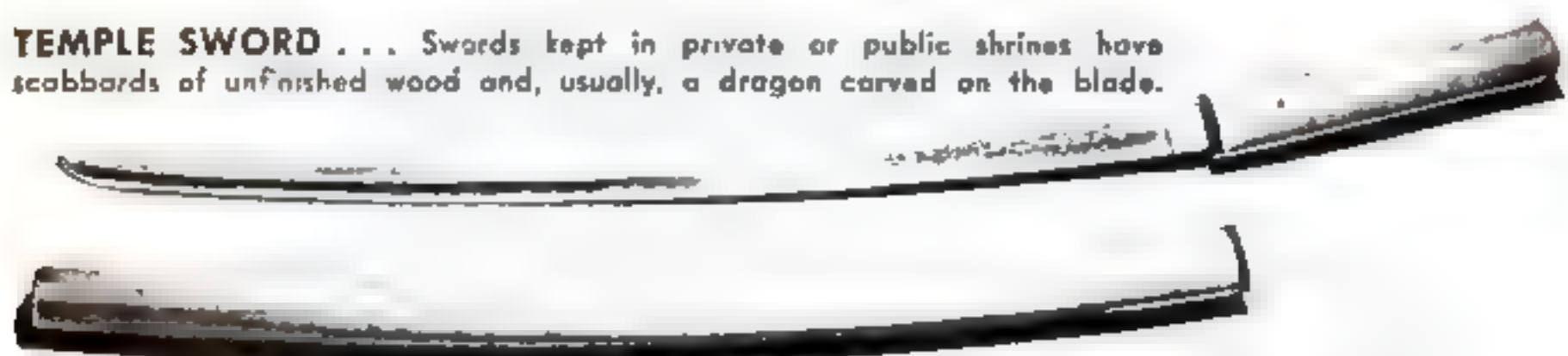
In the early '30s the Japanese Army discarded the Western-style saber and issued a standard *gun-to*, an all-metal, mass-produced replica of a typical *Nippon-to*, for officers and sergeant majors. Most officers, however, from vanity or superstition, preferred to carry hand-forged swords inherited or bought. These were not carried merely for dress; the Jap officer took his fencing lessons seriously and expected just as seriously to use his sword in combat.

There are four chronological divisions to *Nippon-to*: *gun-to*, or government issue; *shinshin-to*, or very recently forged swords; *shin-to*, or recently forged swords; and *ko-to*, the true antiques.

While the oldest Japanese swords brought to the U. S. within the last 10 months date from about 1200 A.D., Japs claim some of the swords in their Shinto shrines—the Imperial *Kusanagi* at Ise Shrine, for example—are as old as their mythological history, some 2,600 years. *(Continued on page 122)*

A likeness of the Kusanagi, claimed to be the oldest Japanese sword in existence, has been carved on the newer blade above.

TEMPLE SWORD . . . Swords kept in private or public shrines have scabbards of unfinished wood and, usually, a dragon carved on the blade.



SHORT SWORD . . . Most wakizashi (short sword) blades are 18 to 28 inches long. Frequently, a small knife or kozuka is fitted into their wooden scabbards.



GREAT SWORDS. The *tachi* (great sword), made for pitched battles, usually has 10-inch handle and 30-inch blade.

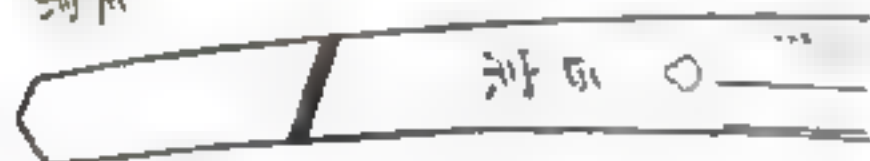


Every school of swordmaking guarded its own formula and technique. *Shinshun-to* schools emphasized quantity rather than quality. But *shin-to* and *ko-to* blades were made with great skill and extremely painstaking labor. Steel totaling four or five times the bulk of the finished blade was heated and hammered thin, folded into itself, then

again heated and flattened. This refining process was repeated about 15 times, with charcoal made of straws for a reducing agent. Frequently several blocks of steel of different grades were treated and finally combined to make a single blade.

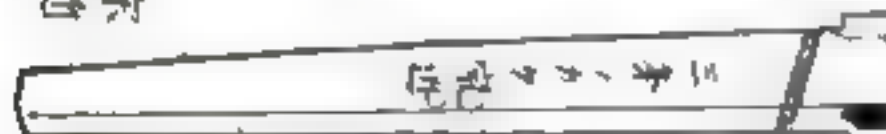
Swordsmiths stressed "the development of the blade's soul," which meant the observ-

明治



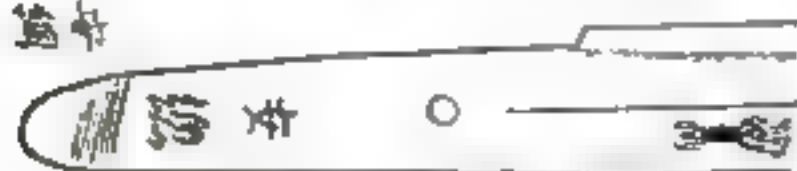
1 A blade forged by Goro Okazaki Mamamune (1264-1344) sold before the war for 20,000 yen.

江戸



2 Sword by Sanjo Munachika (10th century) was once worth 15,000 yen, has often been copied.

室町



3 Yasutsuna's blades (9th century), called the best by some experts, have cost 9,000 yen.

MADE BY JAPAN'S

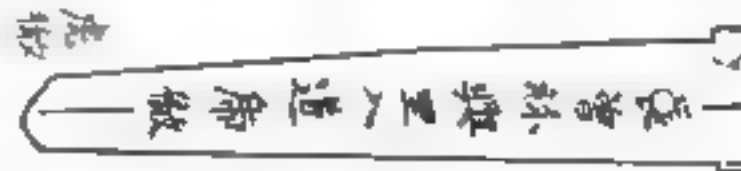
Before the war, Japanese officers and other collectors paid thousands of yen (then worth 25 cents) for blades forged by their country's 10 best swordsmiths. Such swords

明治



4 In Jap drama, villain wears a sword by Muramasa (14th century). Prewar value: 5,000 yen.

明治

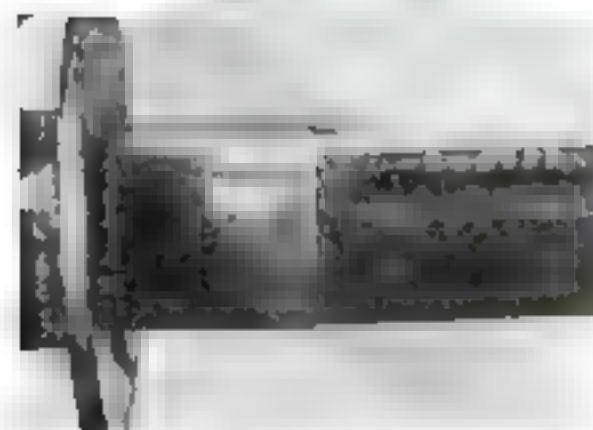


5 One of the best of the semimoderns was Okisato (17th century). Blades once cost 3,000 yen.

According to legend, the Kusanagi was found in the belly of a dragon [carved above] slain by a brother of the Sun Goddess.



GOVERNMENT ISSUE. Many *shinshin-to* (above), hand-forged since 1868, had reputable makers but were standard military equipment. *Gun-to* (below) were machine-made by the hundreds of thousands during World War II, had serial numbers (left) on them.



ance of certain rituals while the sword was being forged. A prayer mumbled with each stroke on the anvil was believed to have a spiritual effect on the steel.

After the steel had taken shape, it was partially coated with layers of fine clay, heated, and dipped in warm water. This final process tempered the cutting edge, which had been left uncoated. The wavy line effect seen on many old blades was the

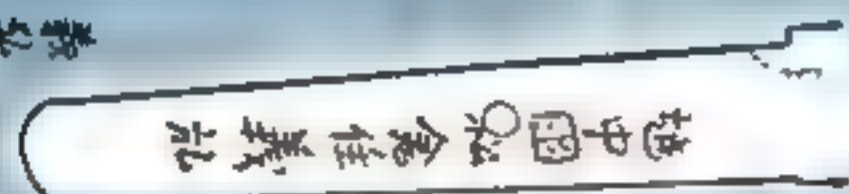
visible result of this artistic clay-coating.

Finally the blade was sharpened and polished by hand; a month's job for an expert using varying grades of soapstones and fine talcum powder. An orthodox Jap would never use oil in caring for his sword or touch the steel with his fingers; nor would he sharpen it more than once in a lifetime. His mouth was stuffed with a rag so that his breath wouldn't tarnish the polish.

TOP SWORDSMITHS

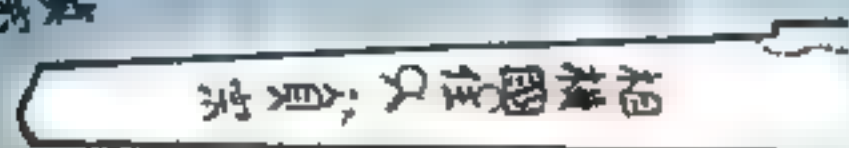
(shown here) are identified by the shapes of their hilts and the signatures of their makers. GIs who compare their sword souvenirs with these may find them historic.

6



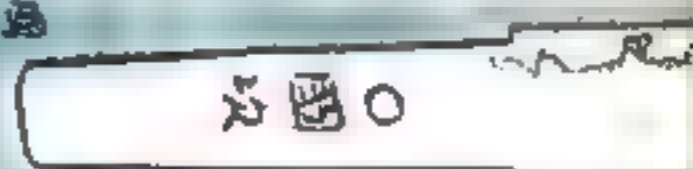
Prices rose to 10,000 yen for a sword by Yashiro (14th century), best Masamune disciple.

7



Sadamune (1296-1345) was an adopted son of Masamune. Japs paid 9,000 yen for his swords.

8



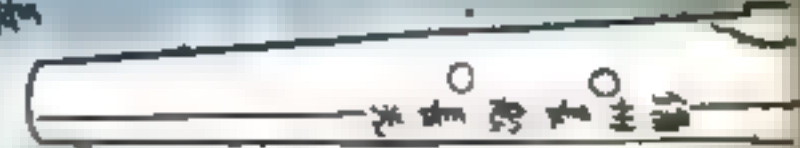
Unorthodox Kunitzugi (14th century) made flexible swords, which later brought 8,000 yen.

9

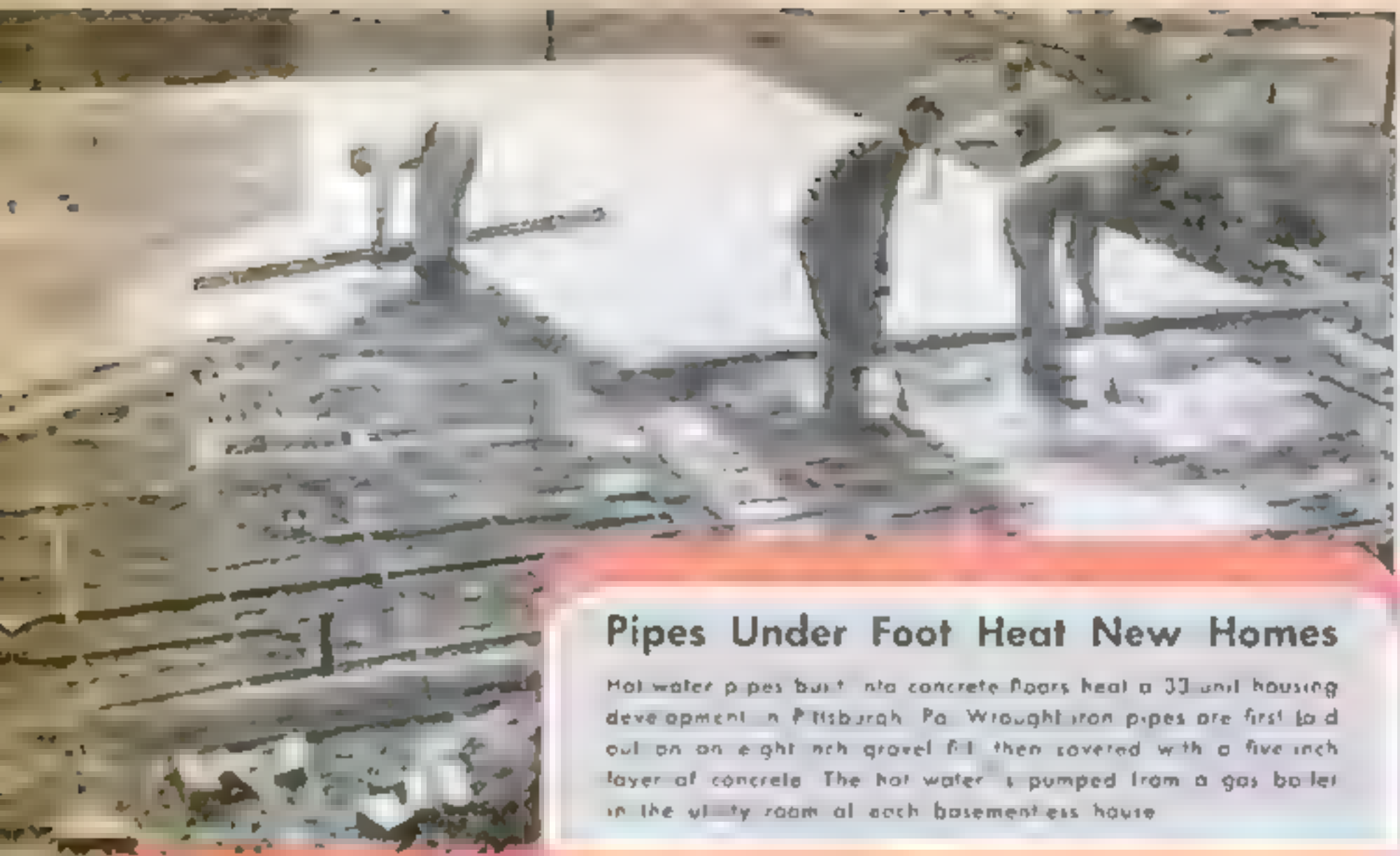


Saburo Kaneuji was a swordmaker of the early 14th century. His blades have cost 7,500 yen.

10



Nagamitsu's (13th century) keen blades, once worth 7,800 yen, split beans dropped on them.



Pipes Under Foot Heat New Homes

Hot water pipes built into concrete floors heat a 33-unit housing development in Pittsburgh, Pa. Wrought iron pipes are first laid out on an eight-inch gravel fill, then covered with a five-inch layer of concrete. The hot water is pumped from a gas boiler in the utility room of each basementless house.

Iron Monster Wipes Out Forest

This bulldozing behemoth bowls over trees from four to nine inches in diameter as it levels more than two acres of woods an hour at Deer River, Minn. The combination Caterpillar tractor and LaPlant Choate brushcutter and tree-dozer is clearing a heavily wooded area for mineral development.



QUIETING the **SMALL FRY** of the **SKY**

DESIGNERS are beginning to cut down the three chief sources of noise in the lightplane: the propeller, engine exhaust, and engine clatter.

Engine clatter is all that conglomeration of small noises arising out of the intake of air, scraping of pistons, tapping of valves, grinding of gears, etc. It will reduce gradually with advances in motor design, which bring about fewer moving parts and finer machining of the remaining parts. For the present, the best answers lie in the effective shrouding or cowlings of the engine and possibly the installation of sound-absorption materials (soundproofing) inside the cowlings.

The major noise problems—propeller and engine exhaust—and how they are being combatted are graphically shown in the pictures below. As a propeller revolves in the air, it throws off a series of waves of atmospheric pressure that blast out at a

speed of roughly 1,000 feet a second. When they strike the ear they register as sound. The number of waves striking per second determines the pitch, and the force with which they strike determines the sound's intensity or loudness. A secondary source of propeller noise, called the vortex note, arises from the "burbles" or turbulences set up as the air flows over the blade and drops off the trailing edge. The two-bladed propeller kicks up more decibels than any known propellant in modern transportation.

(The decibel is a unit of measurement of the loudness of sound. Ordinary conversation lies between 40 and 60 db.)

As for the open-exhaust engine, its noise at cruising speeds is considerably louder than that of the three- and four-bladed propellers. The answer here seems to be mufflers. A number of lightplane manufacturers either have as standard equipment, or are working on, engine mufflers, partly because they realize the need of quieting planes if they are to be used around in-city airfields and partly for the comfort and convenience of their prospective plane buyers. Engineers report a considerable reduction in exhaust blast without any material loss of power.

Courtesy National Aeronautics

Noise Problem One
A propeller is the most efficient noise-maker known—and the greater its speed, the louder its noise becomes.



The usual 4-foot prop creates 83 db.

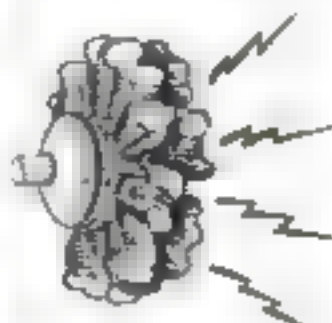


A 7-foot prop cuts down 5 db.



A 4-bladed prop cuts 10 db. more

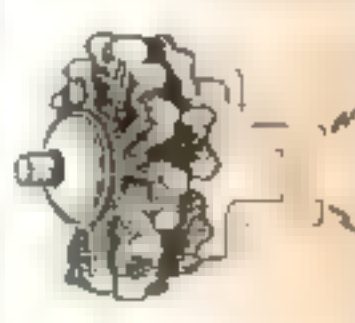
Noise Problem Two
Engine exhaust gases, being hotter and denser, explode loudly into outside air when released.



An unmuffled engine creates 83 db.



A single muffler cuts 7 db.



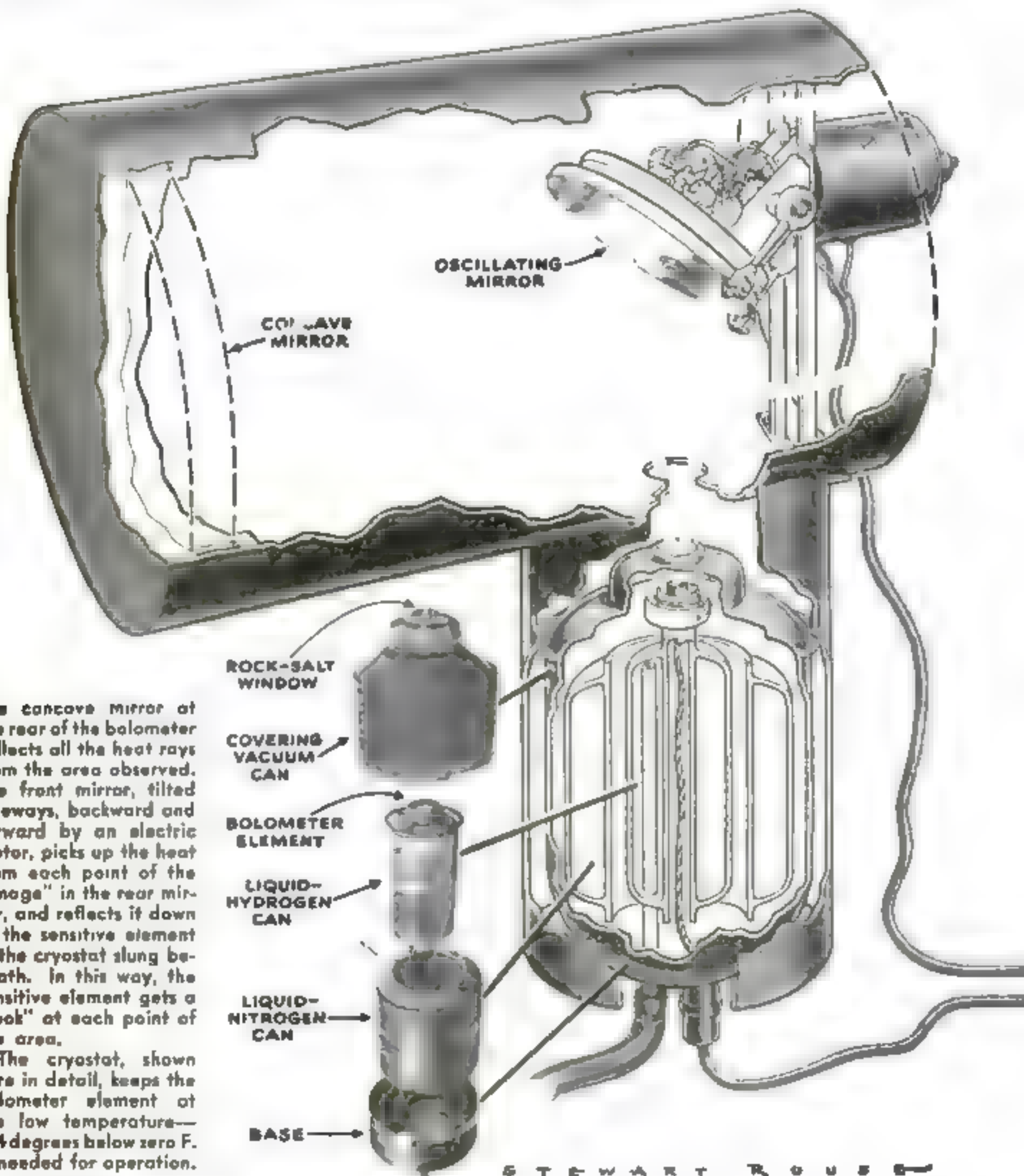
A "silomex" muffler cuts 13 db.

AN EYE FOR HEAT

SCIENCE has outdone the cat with a new device that can really see in the dark. The superconducting bolometer, developed at Johns Hopkins University's Cryogeny (refrigeration) Laboratory by Dr. Donald H. Andrews and three student associates, will spot a truck moving in complete dark-

ness five miles away—and instantly trace its outline on a screen.

Actually an ultrasensitive heat-measuring instrument, the bolometer detects heat radiating from men, vehicles, and buildings. Unlike the Army's sniperscope (PSM, June '46, p. 73), which reveals a night-hidden object



The concave mirror at the rear of the bolometer collects all the heat rays from the area observed. The front mirror, tilted sideways, backward and forward by an electric motor, picks up the heat from each point of the "image" in the rear mirror, and reflects it down to the sensitive element in the cryostat slung beneath. In this way, the sensitive element gets a "look" at each point of the area.

The cryostat, shown here in detail, keeps the bolometer element at the low temperature—434 degrees below zero F.—needed for operation.

New bolometer that "sees" warmth miles away will help fight disease, warn of fire, catch burglars, and spot heat leaks.

by sending out a beam of infra-red rays and showing on a screen the reflections from the object, the bolometer does not emit rays.

Like early television cameras, the bolometer employs a mechanically oscillated mirror to scan the area under observation. Instead of a cell sensitive to visible light, however, it has a tiny strip of alloy that responds to the invisible light of the infra-red spectrum—heat rays. This alloy—the rare metal, columbium, alloyed with nitrogen—converts the varying heat radiation it receives from the mirror into electrical impulses, which are amplified and fed into a cathode-ray tube. Movement of the cathode beam is synchronized with the oscillating mirror, while the intensity of the ray is governed by the impulses from the alloy strip—thus the object being observed appears on the fluorescent screen of the tube just as in a television receiver.

Its high sensitivity and quick action should make the bolometer valuable in science and everyday life. An instrument that can sense the heat of a truck five miles away might remove the danger from night driving. In a bolometer-equipped car, the driver would see a pedestrian or oncoming

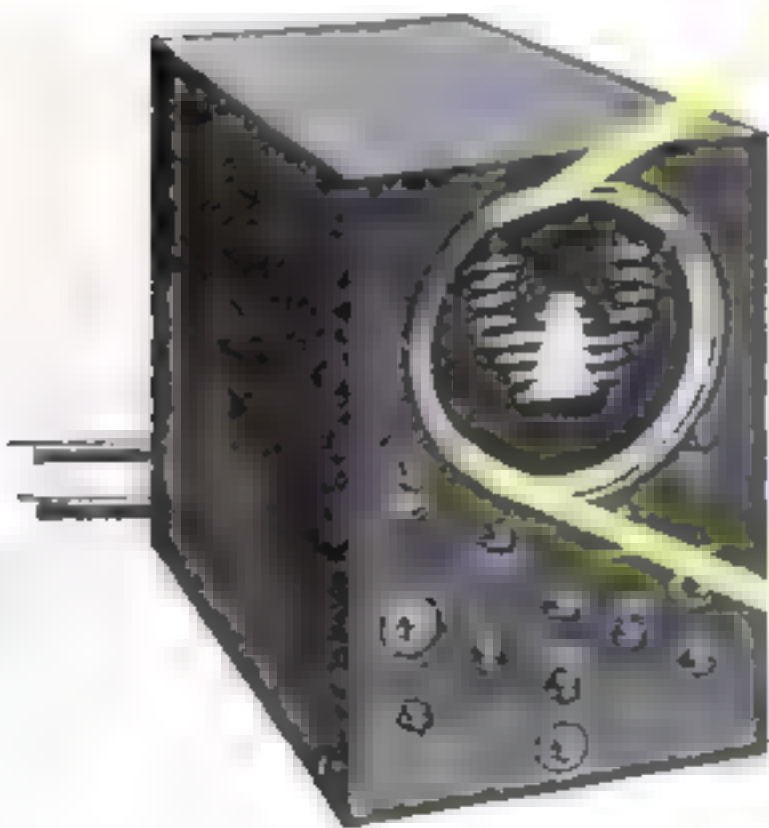
By MARTIN MANN



vehicle on a screen on the dashboard long before he could see either of them naturally.

The bolometer also might be used to detect heat losses caused by faulty insulation of buildings or equipment. Photographic film placed over the viewing screen would make a heat picture of a house, showing exactly where heat was leaking through walls and roof. And suggestions have already been

A man with his arms raised looks like this on the viewing screen of the superconducting bolometer. Made in complete darkness, the first "heat portrait" ever taken shows the bolometer's inventor, Dr. Donald H. Andrews.

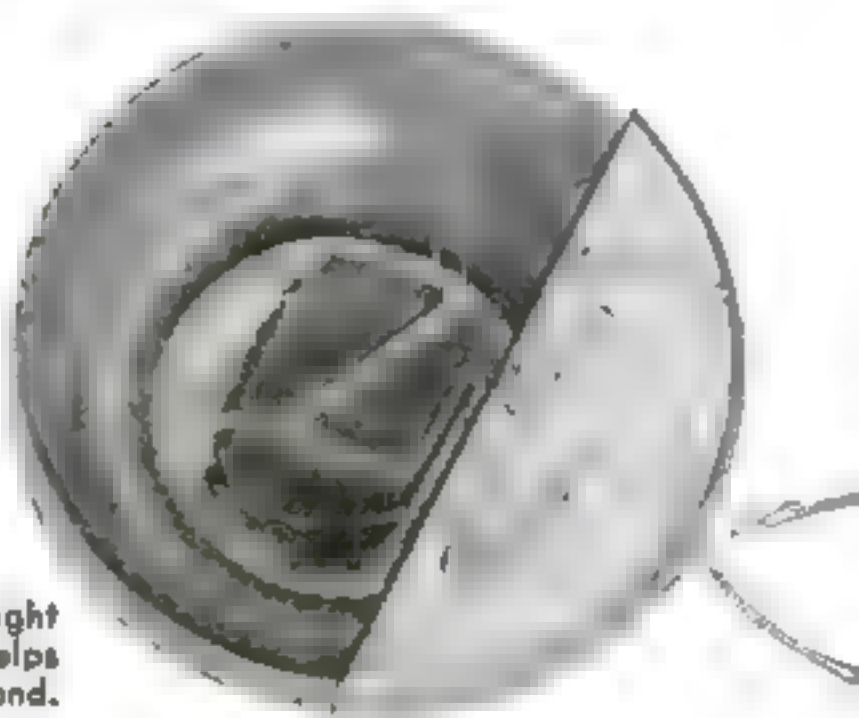




Looking down on the bolometer's electric motor and gears, which oscillate the forward mirror. Parts A and B are the two potentiometers that keep the cathode beam of the viewing scope synchronized with the oscillating mirror.



A rock-salt window protects the bolometer element, columbium nitride, for glass would not transmit all the heat rays detected. Maintained at 434° below zero F. columbium nitride notes a temperature change of one ten-millionth of a degree.



Copper post to which columbium nitride (light gray strip in photo at right) is fastened helps it react in three ten-thousandths of a second.

made for employing the bolometer in fire and burglar alarms.

But most important, its inventors believe, will be the use of the superconducting bolometer as a new tool in scientific research—particularly in medicine and physics.

For the first time doctors will have an instrument sensitive and fast enough to measure accurately the heat radiated from the human body. More precise analysis of body heat is expected to disclose additional information about the fundamental nature of disease and life itself. In physics, the bolometer will make more accurate investigation of the infra-red spectrum possible, and perhaps add importantly to existing knowledge of atomic structure.

Dr. Andrews will begin research this fall into the nature of heat radiations from sugar, fat, and other simple organic substances. Actual medical work, he estimates, can be started next spring.

The bolometer represents eight years' hard work. When Dr. Andrews, while relaxing on the beach at Nassau, first thought of using a heat-measuring instrument as a detector, it was merely a good idea and little more. There was then no suitable heat-measuring instrument. The existing bolometers used a simple platinum strip set in a balanced electrical circuit; thus a change in the temperature of the platinum, altering its electrical resistance, changed the current in the circuit. A galvanometer would then, in effect, register small temperature changes. But this bolometer was not sensitive enough to pick out a truck at five miles.

To improve the bolometer to fit his purpose, Dr. Andrews drew on 25 years' experience in low-temperature research. He knew the strange properties that matter acquires when cooled almost to absolute zero, the unattainable point 459 degrees below zero Fahrenheit where molecular mo-

tion would stop completely. One of these properties—superconductivity—was eventually to solve his problem.

Low-temperature researchers had discovered earlier that electrical resistance—the “friction” with which substances oppose passage of an electrical current—suddenly disappeared in some metals when they were brought to a temperature near absolute zero. If a current were started circling through a ring of metal at superconducting temperature, it would continue indefinitely, provided the temperature did not rise.

Aware of this phenomenon, Dr. Andrews reasoned that an unusually sensitive bolometer could be made by maintaining the bolometer element just barely above the superconducting temperature. Since the drop from normal resistance to superconductivity occurs very suddenly, an element kept at this transition temperature would show very large changes in resistance for minute differences in temperature.

Assisted by Drs. Robert M. Milton and Warren DeSorbo, Dr. Andrews made the first superconducting bolometer by cooling a tantalum element with liquid helium. It was remarkably sensitive, but the apparatus was

bulky and expensive to operate. Through diligent research, Dr. F. Hubbard Horn discovered that an alloy of nitrogen and columbium became superconducting at 434 degrees below zero F.—a temperature easily obtainable with liquid hydrogen, which costs only one-tenth as much as liquid helium.

In the present model, the columbium nitride element rests under a rock-salt window in the center of three concentric copper cans, called a cryostat. The inner can contains liquid hydrogen, the next liquid nitrogen, and the outer can a vacuum.

In operation, a small, steady electric current is passed through the columbium nitride element. Heat rays striking the element change its resistance and cause the electric current output to vary. These variations are amplified by standard, radio-type equipment and fed to a cathode-ray tube.

If the bolometer were mounted in an automobile, for example, the mirror would “look” from one side of the road to the other, shift down a bit and then “look” across again—in much the same way the human eye moves when reading. Whenever the mirror found an object radiating heat, such as a man walking in the road, its heat rays would be reflected to the bolometer element, which would convert them into electrical impulses.

The cathode beam, moving in synchronism with the mirror, shoots electrons at the screen when it receives an electrical impulse, causing the screen to glow at every point where the mirror found heat radiation. In that way, a zigzag outline of the man would appear on the screen. If the object in the road were another automobile, the engine, being hottest, would glow brightest.

As a detecting device, the bolometer is rather expensive to operate, since it requires about \$8 worth of liquid hydrogen and nitrogen for every 24 hours’ use.

The initial investment would not be great, however, since even the first, custom-made bolometers cost only about \$100. And if they were to be mass-produced, Dr. Andrews estimates this would drop to \$25.

Eventual elimination of the need for any liquefied gases, with resulting economies, is Dr. Andrews’ present goal. He has already built the first model of the cryodyne, a refined mechanical refrigerating unit. The first cryodyne produced a temperature of 384 degrees below zero F., and Dr. Andrews expects that improvements will enable it to reach the superconductivity zone.



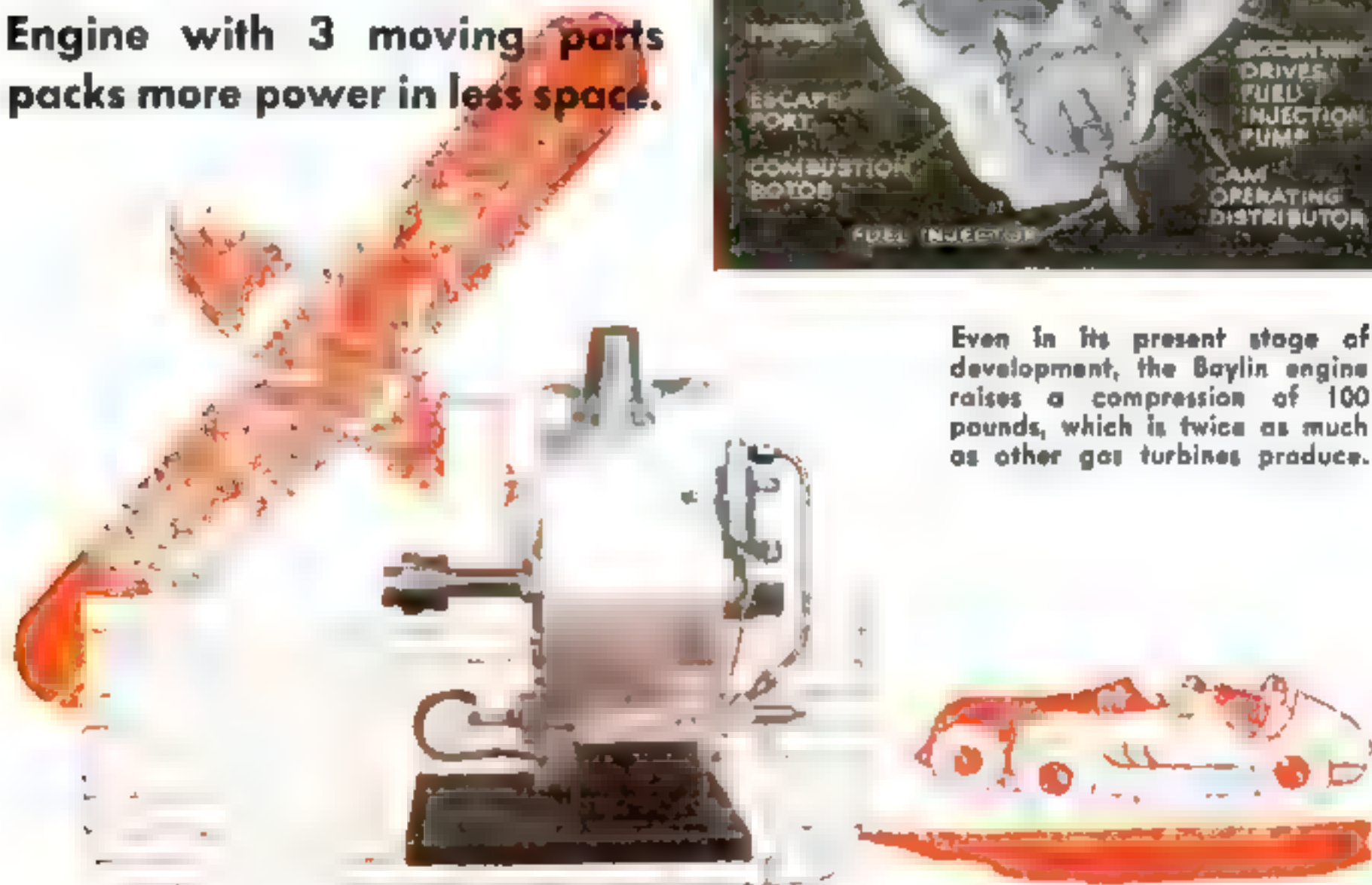
Dr. Donald H. Andrews watches the viewing screen of his bolometer. The miniature camera in front of him is used to photograph the images on the screen.

ROTATING PISTONS

Engine with 3 moving parts packs more power in less space.



Even in its present stage of development, the Baylin engine raises a compression of 100 pounds, which is twice as much as other gas turbines produce.



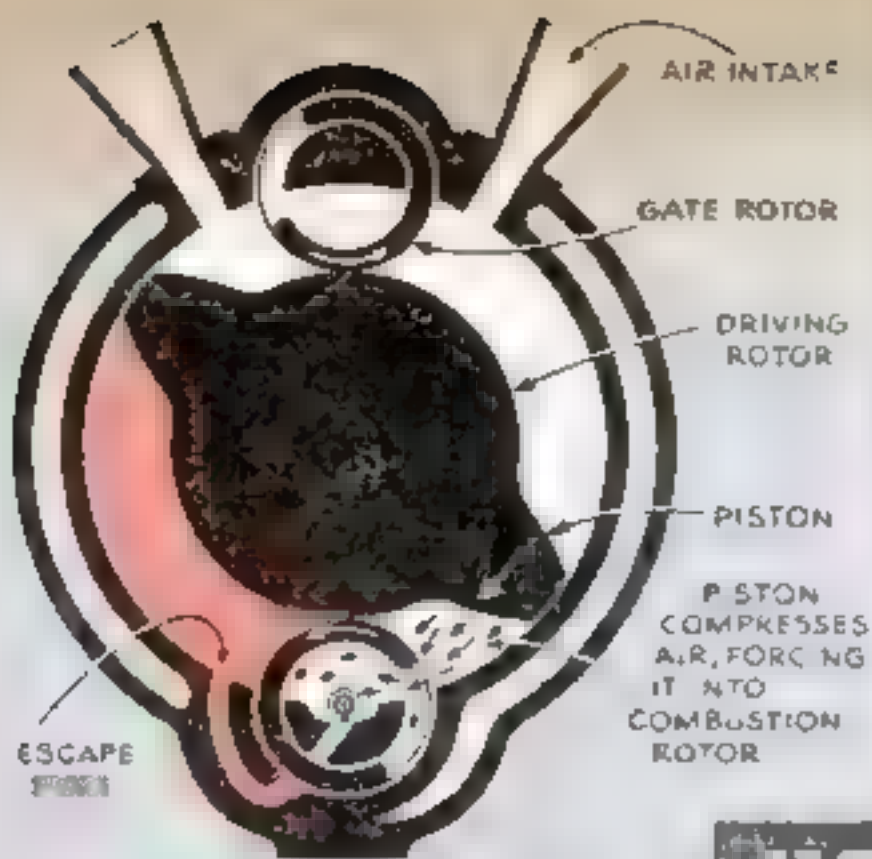
A NEW-TYPE engine that would fit easily into a market basket is designed to power anything from a midget auto to a giant liner economically and with little wear.

The engine, invented by Sam Baylin, Russian-born Canadian citizen of Montreal, is 13 inches high, 10 inches wide, and six inches deep. It weighs 100 pounds and delivers 100 horsepower. Multiple units can be placed in tandem on the same drive shaft to deliver whatever horsepower is required.

Baylin's engine has only three moving parts—driving, combustion, and gate rotors. All are assembled in a housing. The driving rotor carries v-d-shaped pistons on it. When it rotates it synchronizes with the combustion rotor and direct compression of inducted air results. Fuel is injected and ignited. Combustion sends the driving rotor around on the shaft to which it is fastened, and the shaft transfers the mechanical power derived.

In addition to compactness and light weight, the engine has these advantages: there are no reciprocating parts, thus reducing wear and increasing power by eliminating inertia; power flows more uniformly to the shaft than in the conventional piston engine; and it uses less fuel because little energy escapes from airtight "cylinders."

The Baylin engine should interest plane builders, who constantly fight the weight-per-horsepower bogey, because (1) of small frontal area; (2) lighter materials can be used to build it (housing is now made of cast iron), and (3) it can easily be converted into a highly efficient compressor unit for jet-propelled aircraft. This is because the engine has a high ratio of compression to the fuel consumed. It packs air tighter than the turbine impeller wheel. Most gas turbines use two-thirds of the total power they produce for compression.

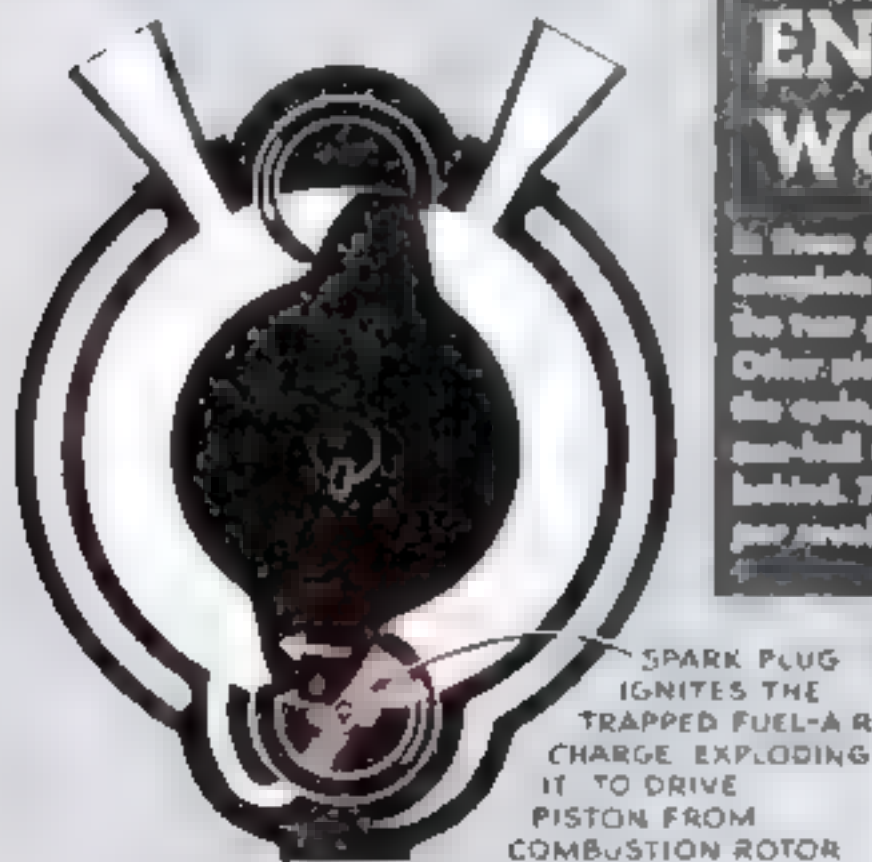


① COMPRESSION STROKE

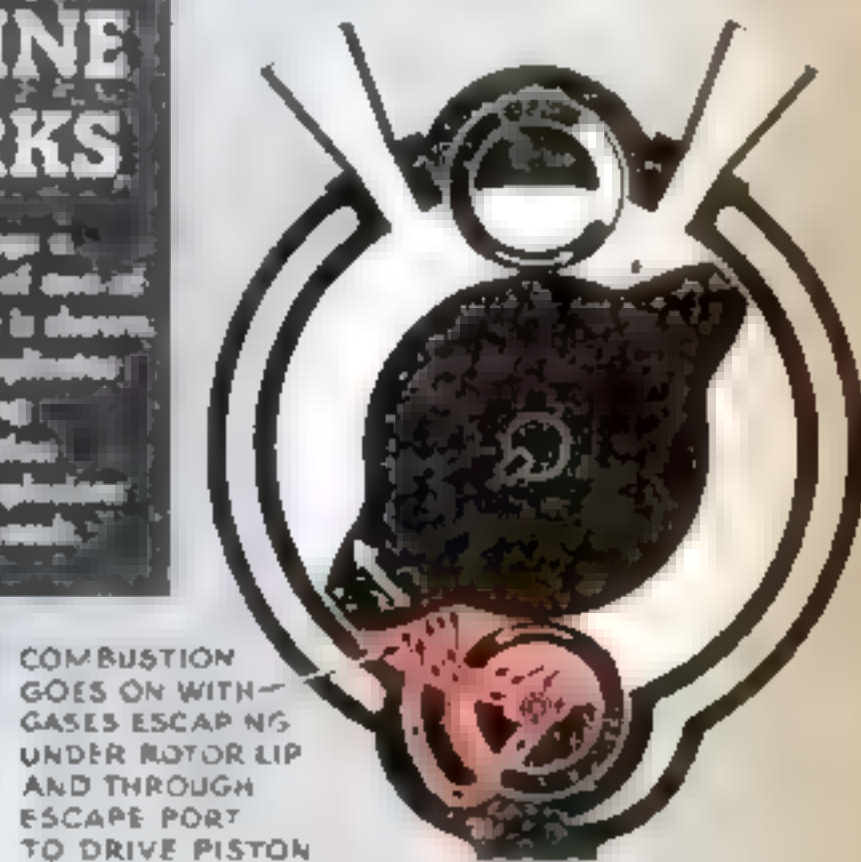


② FUEL IS INJECTED

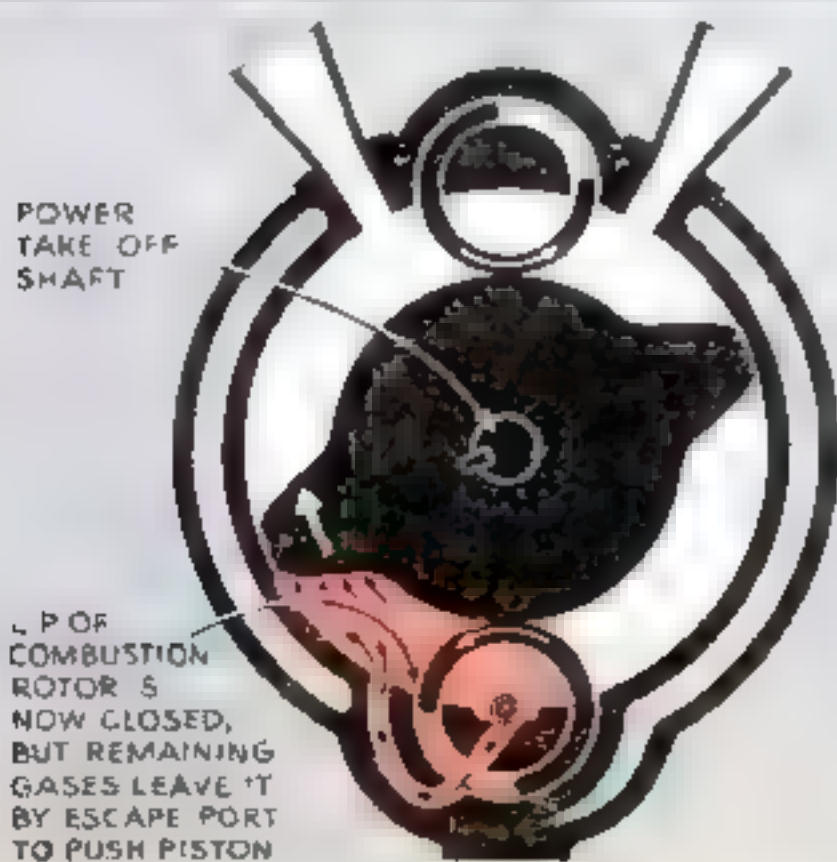
HOW BAYLIN ENGINE WORKS
 In these drawings a complete cycle of one of the four pistons is shown. Other pistons duplicate the cycle, turning gas-bell revolution behind. Two explosions per revolution result.



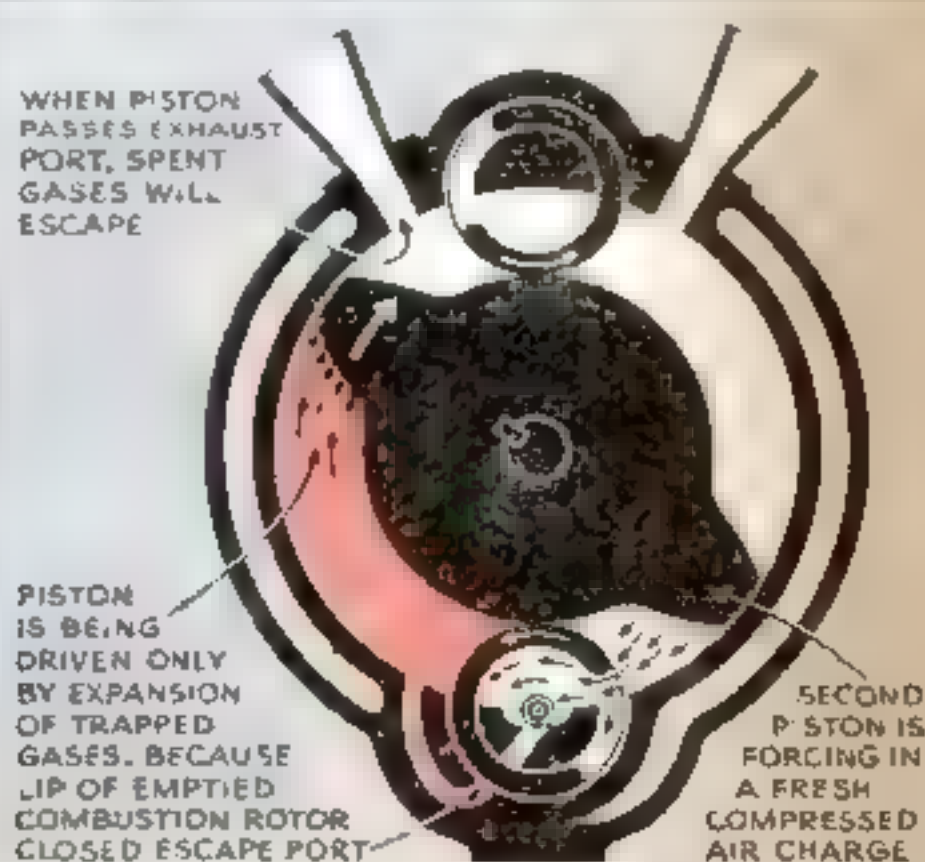
③ IGNITING THE CHARGE



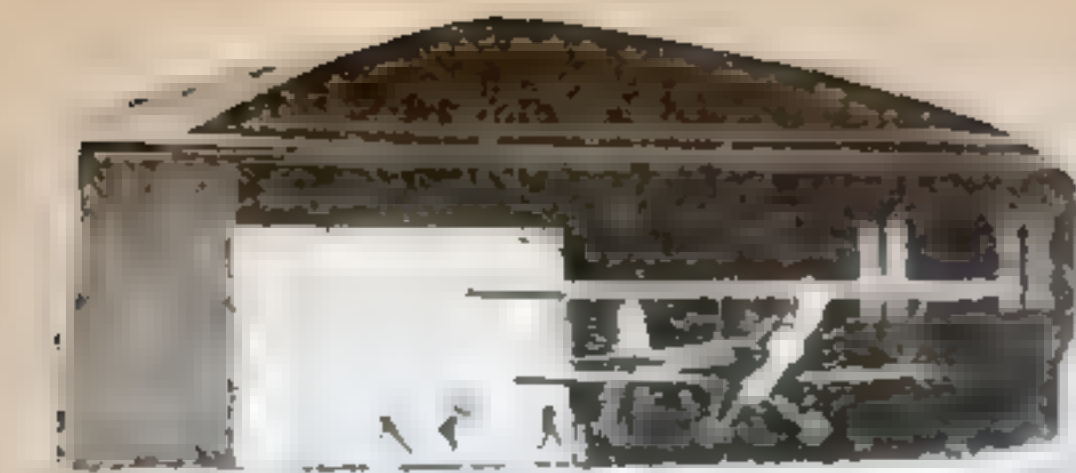
④ POWER STROKE (FIRST PHASE)



⑤ POWER STROKE (SECOND PHASE)



⑥ POWER STROKE (THIRD PHASE)



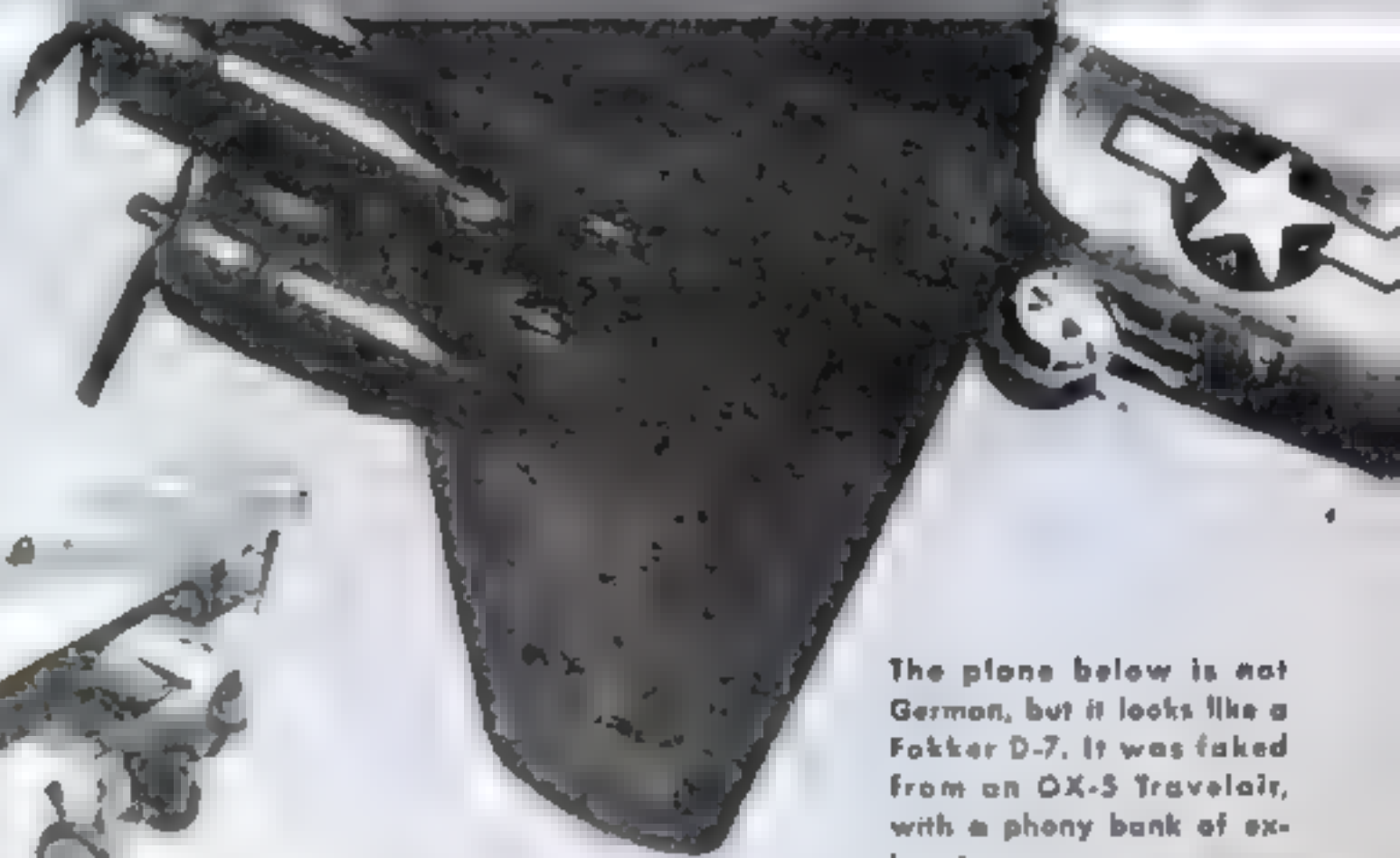
Farmer stunt pilot Paul Mantz swoops through an open hangar in one of his early biplanes



In Mantz's air force is this B-17 Flying Fortress, minus war paint, as recommended by combat commanders in World War II

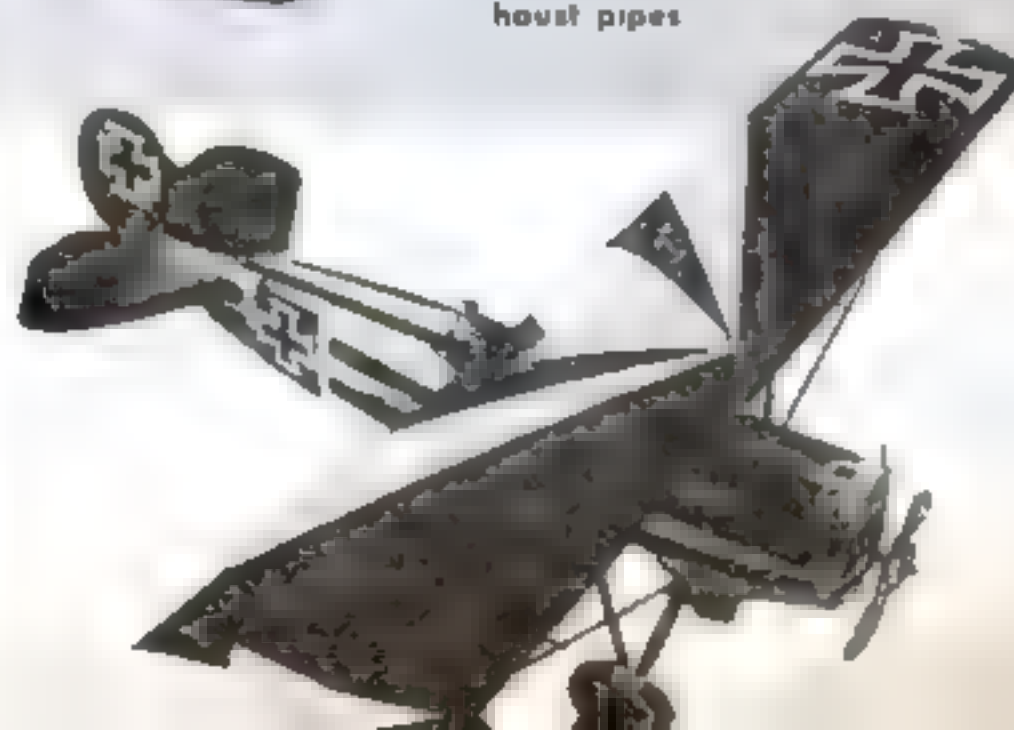
Hollywood's One-Man Air Force

This Spad (below), relic of World War I, has appeared in "Men With Wings," "Capt Eddie," and other films



The plane below is not German, but it looks like a Fokker D-7. It was faked from an OX-5 Travelair, with a phony bank of exhaust pipes

Another Mantz plane that fought during World War I is the old SE-5 shown below.

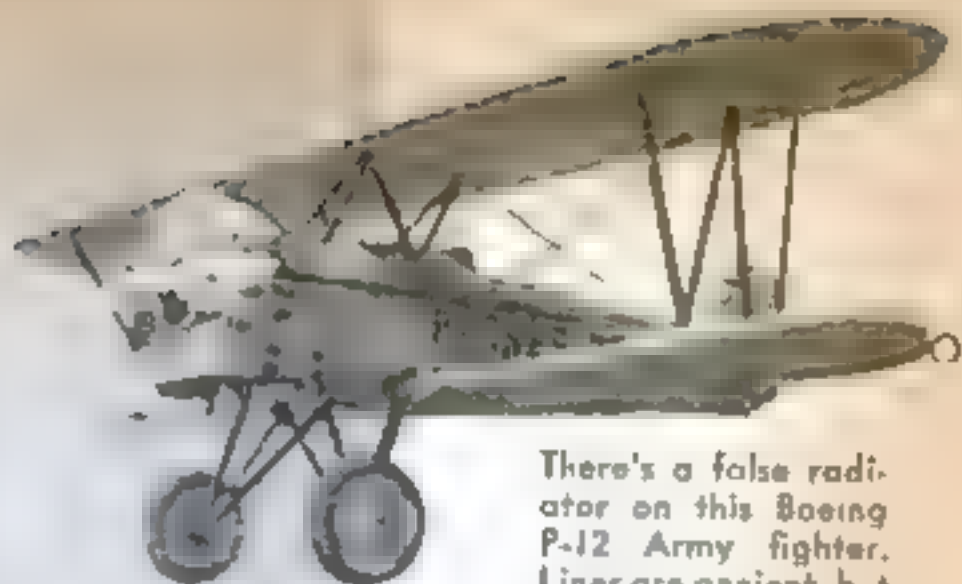


By **ANDREW R. BOONE**

THE LARGEST private air fleet in the world today belongs to Paul Mantz, a former stunt flyer. It is a Hollywood enterprise that can supply, for any thriller being filmed, a single fighter of World War I vintage or a modern combat group of fighters and bombers. Mantz's current stock consists of 560 airplanes, nearly all combat types. He can photograph a scene from his slowpoking Stinson L-1 reconnaissance monoplane, fly a B-17 or B-24 from a mountain hideaway, roar across a field in a practical mockup of a P-47, or put a Spad or Fokker through an Immelmann.

After scouring the nation for 16 years, Mantz has 22 old timers in his hangar in San Fernando Valley, Calif. They include Jennies, DHs SE 5s, Spads, Nieuports, Thomas Morse Scouts, Orenco's (three-place Jennies), one Oriole and one German Fokker D-7 complete with Iron Cross and red plumage. All have worked in the movies.

Mantz recently bought from Army surplus 475 planes that cost \$117,000,000 to build. Many of them will fly for the movies at rentals varying from \$100 to \$1,000 a day.



There's a false radiator on this Boeing P-12 Army fighter. Lines are ancient, but a 450-hp. Wasp engine gives it speed.



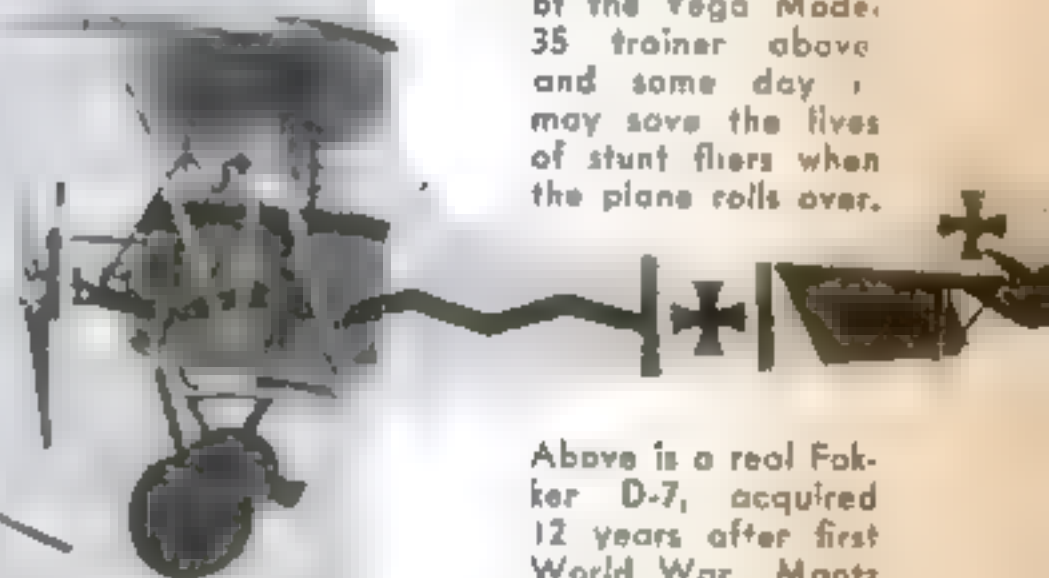
Everyone will recognize the Flying Tiger insignia but the plane above is really a practical mockup of a Curtiss P-40. It tops at 60 m.p.h.



There's a crash bar between the cockpits of the Vega Model 35 trainer above and some day it may save the lives of stunt fliers when the plane rolls over.



This Oriole has the first monocoque fuselage ever designed.



Above is a real Fokker D-7, acquired 12 years after first World War. Mantz repaired the plane, then flew it in six motion pictures.

You may have seen this 20-year-old Nieuport in "Hell's Angels" or other pictures.



Petri dishes show heaviest microbe "catch" during cafeteria rush hour.



New "Noses"

analyze air

THREE of the "snoopiest" instruments ever devised have recently been unveiled. Two of them, invented at Northwestern University, smell out the presence of extremely minute amounts of gas and smoke in the air. The third, developed by General Electric, catches and counts invisible microbes.

A rugged, portable device, the Northwestern Ultraviolet Photometer detects as little as one part of gas in a million parts of air. During the war, with ultraviolet light, it tested the penetration of poison gas through masks, measured the effects of gas bombs in buildings and fortifications, and in the field tested the movement of gas clouds. Its inventors, Dr. Irving J. Klotz and Malcolm Dole, now expect it to provide continuous measurement of toxic vapors in factories and mines.

The Northwestern Photoelectric Smoke Penetrometer is an electronic sniffer so sensitive it can detect 1/100,000 of an ounce of smoke in a room 30 feet square. It was developed by Dr. Hugh B. Pickard and Frank T. Gucker, Jr., chemists, and Chester T. O'Konski, electronics expert. The instrument's peacetime value will include its use in studies of industrial plants, smoke elimi-

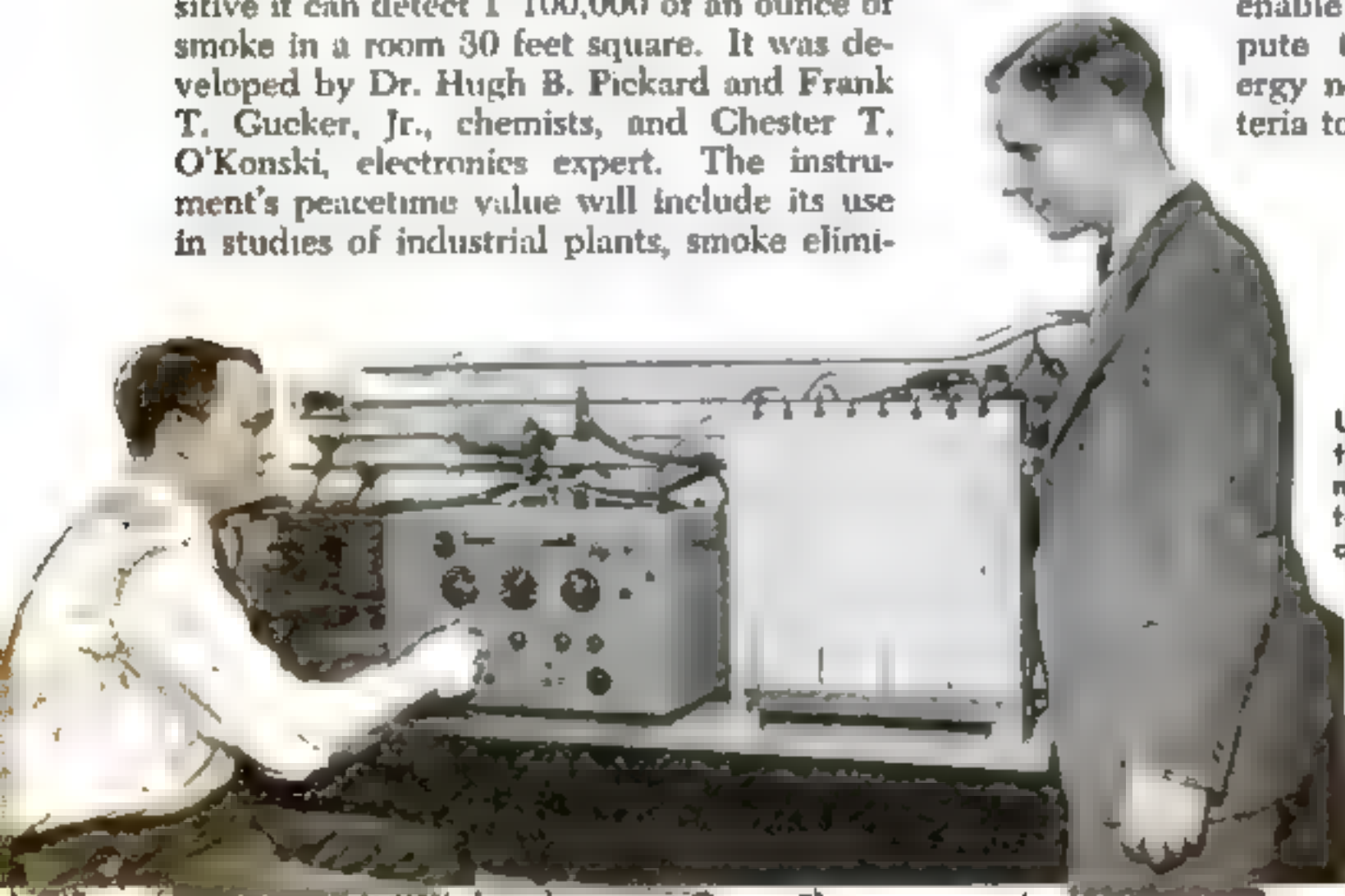


Dr. Matthew Luckiesh inserts a bacteria-free dish into the 12-pound G.E. electrostatic air sampler.

nation, and air purification and conditioning systems.

The other detector is the G.E. bacteria counter, which "inhales" air at the rate of half a cubic foot a minute. Germ-laden particles are attracted by electrostatic fields and intercepted by petri dishes coated with a nutrient jelly. This jelly traps the microbes in the same way as houseflies are caught by fly paper. After a 40-hour incubation period, bacterial counts are made from the germ colonies that appear on the jelly.

The air sampler will enable engineers to compute the germicidal energy needed to keep bacteria to a minimum.



Using the Smoke Penetrometer to test a gas-mask canister (top center). Tubes (right) indicate rate of air flow.



All-Weather Electric Fence Control Built by Toy Maker

A CONTROL for electric fences that prevents moisture from interfering with their effectiveness has been developed by the Lionel Corp., manufacturers of toy trains.

The mechanism is hermetically sealed in a molded glass "blister." It operates with equal efficiency on one "hot shot" battery (above) or four No. 6 dry cells.

Electrical Aerial Camera Now Films Action on Ground

FAIRCHILD's famous nine-pound, K-25 aerial camera has been adapted for taking action pictures on the ground. It photographs from 25 feet to infinity, mounts a 14-inch f/5.5 telephoto lens. It gets its power from a tiny 24-volt DC battery pack, carried in a metal case on a shoulder strap. Each roll of film provides 50 four-by-five-inch exposures at the rate of two per second.



Makes Single Pair of Shoes Do for Roller and Ice Skating

ROLLER skates and ice skates have been provided for the same pair of shoes by J. W. Howard, of Brigham City, Utah. All a skater has to do when winter comes is to unscrew the rollers and attach the blades. Both are on pinions, which can be inserted in the framework and secured with lock nuts.

"D.D.T. Lite" Lures Insects to Death

THIS new device for killing insect pests at night attracts them to a light within a wire cage coated with D.D.T. crystals. D.D.T. screens to fit over regular light bulbs are also being manufactured.

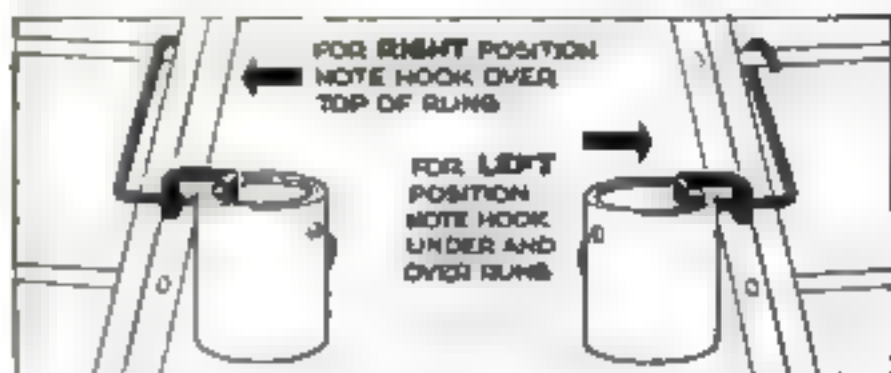


HOME OWNERS



LIVING IN A SILO means home sweet home for Mr. and Mrs. Joe F. Nichols, of Littleton, Colo., a suburb of Denver. They have three cylindrical rooms, a basement, and a 12' high attic that could be converted to another room if needed. The rooms are 12' in diameter and, Mrs. Nichols boasts, have no corners to clean.

STYLING THE SINK. Eye appeal is a feature of the faucets in a model kitchen developed by the General Tire and Rubber Company of California. The spout, which is designed to give maximum coverage, is made in a unit with the hot- and cold-water valves for installation on the ledge of the sink. It can be swung out of the way when not in use.



PAINT IS WITHIN EASY REACH when the can is hung on a rung of the ladder by the adjustable hook shown above. The clamp fits under the lip of the can and holds it securely, and the handle is always out of the way of the brush. A simple twist of the hook adjusts the device for use on the right or left side of the ladder, as shown in the drawing.

NEW DINETTE TABLES for use right in the kitchen slide out when a meal is to be served and are quickly hidden away after the table has been cleared. The legs are on rollers and tuck away at the sides of the cabinet. Coppes, Inc., of Nappanee, Ind., is the maker.



AMERICANS *ROLL THEIR OWN*



THIS HYBRID suggests what can happen when aircraft parts are employed in making an automobile. Jack Norvell of Los Angeles used an increased gear ratio, a long chassis, and dual radiators, one on each side just forward of the rear wheels. Note the excellent visibility afforded the driver. In preliminary tests Norvell reached a speed of 131 m.p.h. with a Chrysler engine.

FEATHERWEIGHT is the word for the little car at the right. It weighs 500 lb., just about one fifth as much as the standard jeep. Emery Kent, of Wichita Falls, Texas, the builder, made many of the parts by hand. He tells of getting 50 miles to the gallon, and 50 m.p.h. top speed.



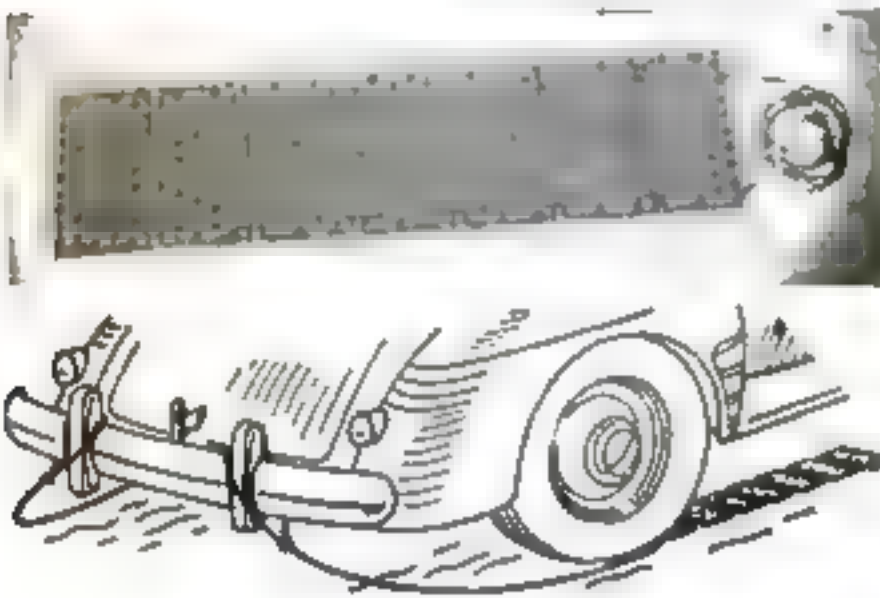
REAR-WHEEL STEERING, using a pair of wheels mounted close together, is one feature of this car, built by Dale Ashenfelter while he was stationed at Kirtland Field, N. Mex. Here he's looking into the luggage compartment, which is at the front of his car. The engine is in the rear, and drives the car at a maximum speed of 55 m.p.h. He says fuel consumption is small.

"THE ROAD RUNNER." Two and a half years plus \$2,000 were used by Arden Edwards, of Burbank, Calif., to put together his dream car. It's an underslung job—less than 5' high—and the one-piece steel body is wider than usual. Four people can sit in the front seat. With its rear-mounted Dodge engine, it can hit up to 100 m.p.h. Edwards naturally chose red as the color for his sporty car, and he mixed the shade himself.



AUTO IDEAS

STEEL RUNWAYS. Patterned after the mats used on wartime airfields, these linked steel plates aid in freeing a car bogged in mud, sand, or snow. They can be folded up to take little space in the luggage compartment, and have cables that can be looped over the bumper so the driver can tow them along behind until he reaches firm ground. The plates may also be employed as wheel chocks and as jack platforms on soft shoulders. The Morton Manufacturing Co., of Chicago, makes them.



A LUGGAGE CARRIER that fits on the roof of a car is one answer when the luggage compartment in the rear won't hold all the equipment for a vacation or fishing trip. The carrier is a simple canvas bag, made by the Kari-Top Co., Dayton, Ohio, and is adjustable to fasten securely to any coach or sedan roof. A zipper closes the bag and keeps out rain and dust. When not in use, the carrier can be easily removed and folded compactly into a small box, which can be stowed away in the car or garage.



A RUBBER GROUND strip for carrying off static electricity from fuel and other trucks has been developed by the U.S. Rubber Co. Made of a special conductive rubber, the strip grounds the frame so any static electricity can pass off harmlessly. Besides being noiseless, the rubber is said to wear longer than the conventional chain.



VULCANIZING A TUBE can be done out on the road with the kit made by J. S. Speaker Corp., of Milwaukee, Wis. A buffer and three patches, with heat units and metal pans, are carried inside the can. The vulcanizer is attached to the top of the can. A tube is buffed, clamped in the vulcanizer with a patch, and the heat unit lighted. Heat and pressure make a well-cured joint between the patch and tube in the same way tubes are repaired with the larger vulcanizing equipment commonly used in shops and garages.



Tuning Up Your Car for 1946 Gasolines

By **BERNARD P. BLANKMAN**

NOTICED anything different about your car since it has been on a rich diet of postwar gasoline?

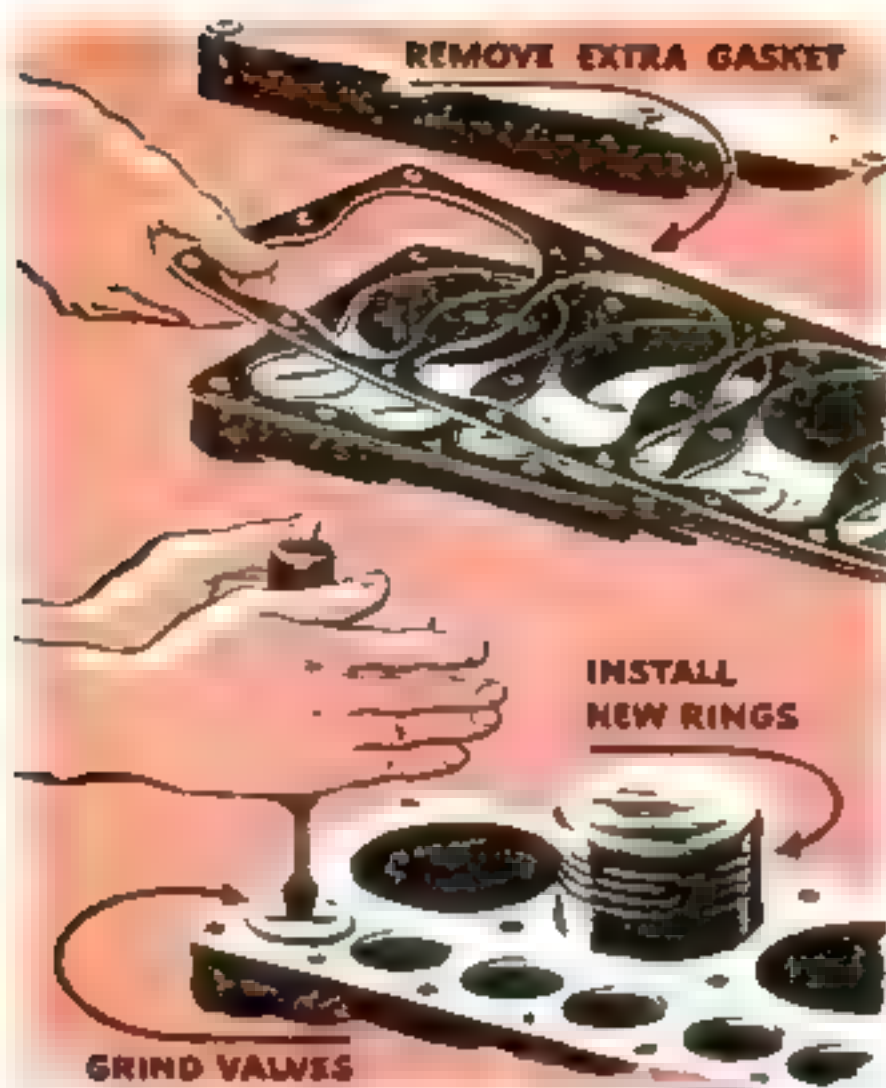
You should—for according to the refiners, the pumps are delivering the highest octane fuels in automotive history. Before the war a peak was reached of 79 octane for premium fuels, and 75 for regular gas. In the war years the figures tumbled to about 75 for premium gas and 70 for regular. A few months ago a survey of gasolines on sale showed 82.3 octane for premium gas and 76 for the regular—the highest they've ever been.

In theory, these gasolines promise higher power, better over-all performance, and greater economy for all cars. But so far as most of the cars on the road are concerned,

these high-grade fuels mean practically nothing, beyond the absence of the wartime "ping."

The fault isn't in the gas. It's in the cars. Most automobiles are not adjusted for the 1946-model gasolines. Some cars are mechanically adjusted for low wartime grades. Other cars are adjusted for the prewar varieties of fuel. In both, all the potential benefits of power, performance, and economy flow into the gas tank and straight out the exhaust. It is possible to save some of the extra zip from the new gasolines. Tuning your auto for higher octane is the way to do it.

Compression, carburetion, and cooling are the first three things to check. Once these matters have been looked into, you'll be ready to tackle the ignition, which is the crucial part of the job. [Turn the page.]



1. RAISE COMPRESSION

1. COMPRESSION. Increasing the compression is one way to wring more power from the 1946 gasolines. The higher octanes will allow higher pressures without knock. It follows that a driver should tune up his car to raise compression as much as possible.

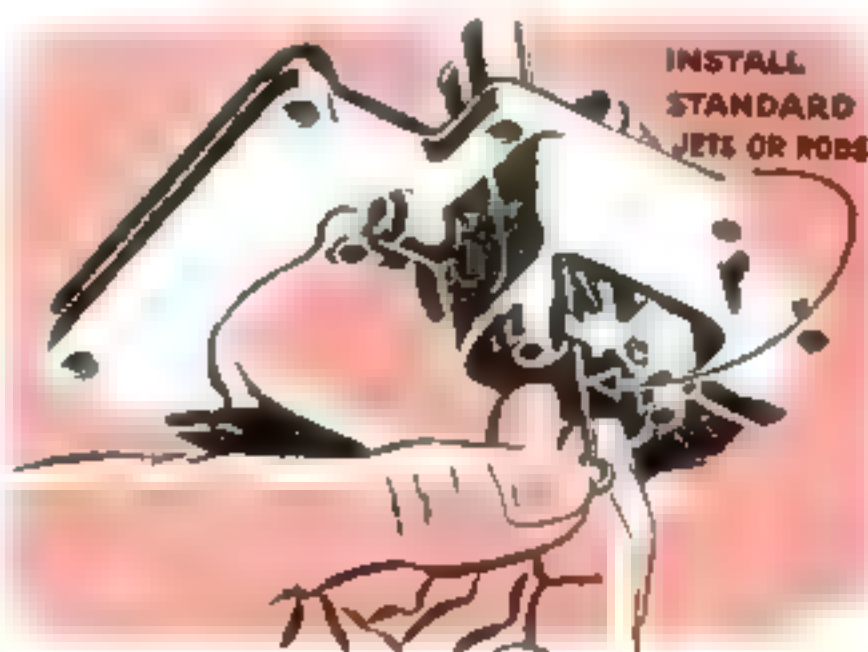
During the war some cars were equipped with thicker cylinder-head gaskets, or double gaskets. These gaskets should be removed and standard gaskets installed. Putting in a new set of rings, and grinding the valves, will step up compression pressure on most cars. The engine becomes better sealed, and the power concentrates on the piston head instead of whistling by the rings or slipping through the valves. This is nothing new, of course. A valve-and-ring job always improves performance. But today, with gasolines packing a stronger wallop, it will put new muscle in your engine.

2. CARBURETION. During the war when octane numbers took a nose dive, some cars had to be fed a richer mixture to keep the knock toned down to a whisper. Carburetors were altered by adding larger jets, or by changing the metering rods. Now that fuels have come back to normal—and more—carburetors should have the standard parts put back. For many drivers, carburetor insides are one of the untouchables of the car engine. In the case of installing jets, or

changing rods, the skilled mechanic is the man for the job. Actually, the mechanic's touch in tuning up could benefit many cars, for precise adjustments pay off in economy and performance.

3. COOLING. Just as higher octane gasolines coming out of the service station pumps mean more power, they mean more heat inside the engine. This heat must be kept under control to protect the engine. Everything under the hood that helps cooling—air, water, and oil—should be ready to do its job.

The engine doesn't get the full quota of cooling if there are bent fins in the radiator, or if the core is clogged with sticks, leaves, and bugs. A layer of rust and scale in the water jacket is like a layer of asbestos around a pipe. Rust and scale keep the heat inside the engine, instead of passing it out to the water. Extra heat in the engine can break down the oil so it loses its lubricating



2. RESTORE CARBURETOR

powers and turns into acids that nibble away at close-fitting metal parts. Here is a list of items that a cooling-system conditioning should include

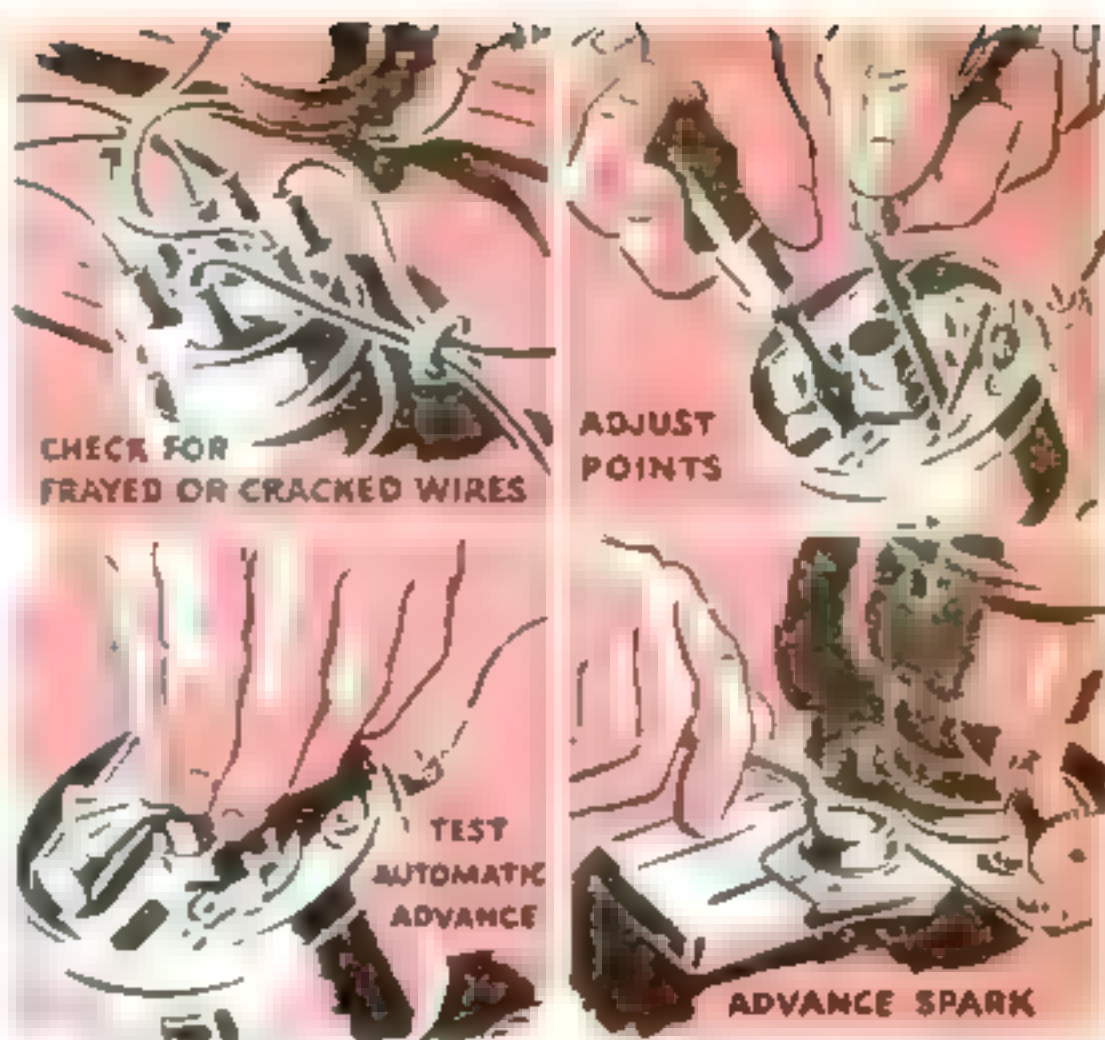
Flush radiator and block. Pressure flushing is the most effective way to clean the system. A good job can be done without pressure equipment by using a cleaning compound and neutralizer. *Test thermostats.* Immerse the thermostat in heated water to be sure the thermostat starts to open at the temperature recommended for your car. Be sure as well that it closes below this point, an overcooled engine wastes fuel and power. *Examine hoses.* Replace hoses that show signs of deterioration or swelling. *Examine*

radiator core. Straighten out bent fins. Have any leaking seams repaired. Blow out dirt and trash from the radiator air passages and radiator grille.

4. IGNITION. Of all the engine adjustments the new gasolines require, the most important is ignition timing. The timing of the spark goes hand in hand with octane rating. This was obvious when there was a war on and the instructions read, "Retard spark and reduce knock." Today the gasolines are more knockproof and so the instructions are to *advance* the spark. A precise adjustment will time the spark to fire when the piston is in the exact position for maximum power. If the firing is to happen this ideal way, the whole ignition system must be tuned to give a hot spark at that moment.

Begin the ignition tune-up by inspecting the wiring. Any cables that show cracked or frayed insulation should be replaced. Examine the spark plugs. Cracked insulators, corroded electrodes, or incorrectly gapped plugs all prevent satisfactory operation.

Tuning up the distributor might begin with an inspection of the points. Put in a new set if they are badly pitted, burned, or worn. While the cap and rotor are off, look them over for cracks, carbon runners, or arc burns. Next, test the automatic advance in two ways. One, put the rotor on the shaft and with your fingers turn

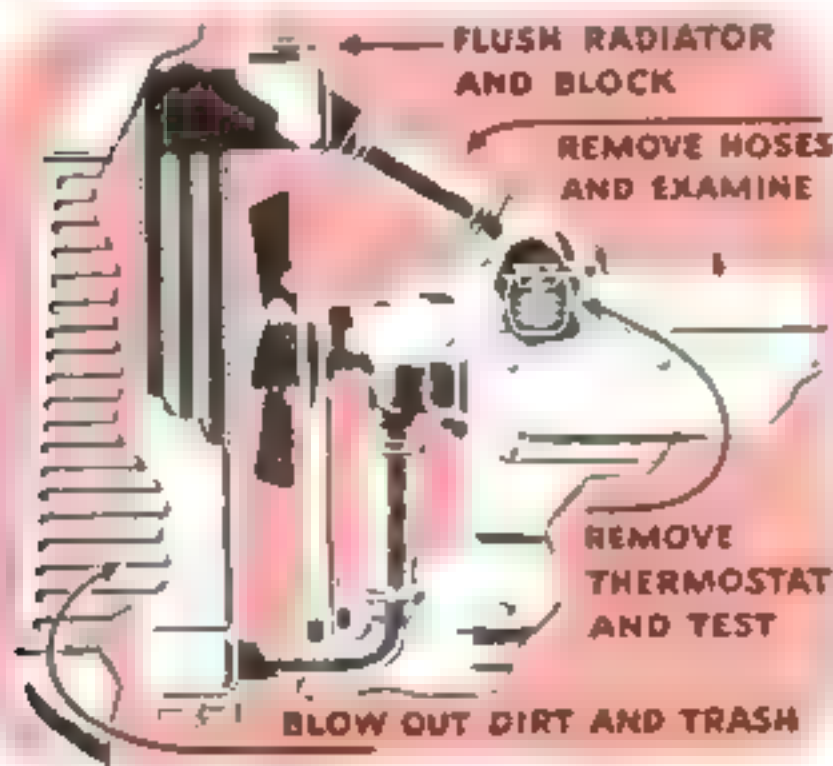


4. ADJUST IGNITION

the shaft as far as the advance will allow. Remove your fingers and the shaft should return to the original position. During the rotation, the shaft should move easily, without binding. Two, crank the engine with the starter while the choke is closed. When this is done, the distributor plate should advance and return. If the plate doesn't advance, the diaphragm is broken. If the plate doesn't return, the spring is broken.

When all ignition parts are in good order, take the car out for a ride till it gets up to operating temperature. Then slow down in high gear and suddenly stamp hard on the gas. The engine should ping or knock lightly till the car speed picks up. If your car has a light ping, the timing is probably all right. If not, the spark can be advanced till the engine does ping lightly in a road test.

For most cars, advancing the timing is a simple adjustment. Loosen the distributor-body screw or screws and rotate the body a few degrees against the direction of distributor-shaft rotation. Road-test the car again, stamping down hard on the gas while driving slowly in high. Keep adjusting till the ping becomes just a little louder than you would like it. Then make your final adjustment by moving the spark back a degree or two to get the exact borderline setting between too loud a ping and just the normal tune the engine should sing under a hard pull.



3. IMPROVE COOLING



GUS strikes oil...*and trouble*

By MARTIN BUNN

GUS WILSON wiped his hands on a piece of waste and turned away from the '41 coupe he had been checking over. "No luck," he reported to the out-of-town salesman standing hopefully nearby. "It might take me quite a while to locate the cause of that vibration. You say it starts when you get up to 35 miles an hour?"

"Yes," the salesman answered, "and as the car goes faster, up to around 50, the vibration gets worse and worse."

"Might take me quite a while," Gus repeated, "and I can't really get to work on your job until I've finished the two others I've promised for this afternoon. I'm sorry, but if you're in a hurry you'd better try someone else."

"Well," the salesman said after a moment's thought, "today all my calls are right here in town, so I can get along on shank's mare—not that I like walking. But first thing tomorrow morning I've got to move on up-state. Think you can have my bus fixed by then?"

Gus told him he couldn't promise but he'd do his best, and the salesman left his car. But it wasn't until four o'clock that Gus got around to the coupe and drove it out for a road test. There was no shimmy or tramp, and the engine ran smoothly enough—but, just as the salesman had said, vibration did start at 35 and get worse as speed increased.

When he got back to the shop Gus called Stan, the grease monkey, to help him. They gave the coupe a thorough checking. There were no symptoms of any engine or transmission trouble that might cause excessive vibration.

"A wheel must be out of balance—although the car doesn't handle like it," Gus decided after more than an hour of trouble-shooting.

They checked the wheels. All of them

balanced. Then they checked everything else that Gus could think of. But at six o'clock, when Stan went home and Gus started downtown for his dinner, the cause of the vibration remained a mystery.

As Gus was going into the Park House dining room the salesman hailed him. "Got my car fixed up?" he wanted to know.

Gus shook his head. "So far I haven't been able to find out what's the matter with it," he admitted. "How long have you been noticing that vibration?"

"Well now, let's see," the salesman said. "It started after I had that little accident—that was a couple of weeks ago."

"So you've had an accident, have you?" Gus asked.

"Oh, it didn't amount to much," the other told him offhandedly. "A trailer truck stopped suddenly, and I ran into it. I wasn't going fast, and all the damage was a busted radiator."

"Well, I'll have another shot at it after dinner," Gus told him. "Something tells me you could have saved yourself money if you'd mentioned that accident sooner."

THE first thing Gus did after he got back to the shop was to raise the coupe's hood and examine the engine fan. Two of its blades were badly twisted. "I thought so!" he muttered. "Ran smack into the tail end of a truck and smashed his radiator, and both he and the so-called mechanic who fixed it were too darned careless to make sure that nothing else was damaged." He set to work to remove the damaged fan. "That bump was what twisted those blades all right—and it's a hundred to one that they're causing the vibration."

After installing a new fan unit, he took the coupe out on the road. There was no vibration at any speed. "Darn that guy!" he growled. "If he'd had sense enough to

tell me he'd been in a front-end collision—oh well, the wasted time goes on his bill. Now to put this buggy away and close up for the night."

But on driving up to the shop he could see his plans for closing were due for a change. A large sedan with its lights out was standing near the door. As Gus turned off the ignition and went into the garage, a big heavy-set man wearing a bushy mustache walked toward him. "You open for business, mister?" he asked. "Excuse me for just walkin' in."

"That's all right," Gus told him. "The shop's supposed to close at six o'clock, but if you're having trouble—"

"I am—I sure am," the big man said. "It's my lights. They've gone out on me three times tonight, and the third time it burned out my last fuse. Mrs. Jackson—that's my wife—sure is provoked with me because I forgot to buy some more fuses. She always makes sure we carry at least half a dozen."

"You don't take any chances, do you?" Gus grinned. "Suppose you bring your car in here where I can get a good look at it."

Jackson did so, his wife sitting rigidly in the rear seat. "Been having much trouble with your lights?" Gus asked.

"No sir, none at all—not until tonight,"

Jackson answered. "Then while I was driving up a hill a little while ago, out they went. When I put in a new fuse they were all right again until I came to a traffic light. Then they went out again. When I put in a new fuse—the last one I had—they burned all right for a couple of miles, but as I started up at another stop light, out they went. I was all out of fuses, so I drove slow till I came to the first place that was open."

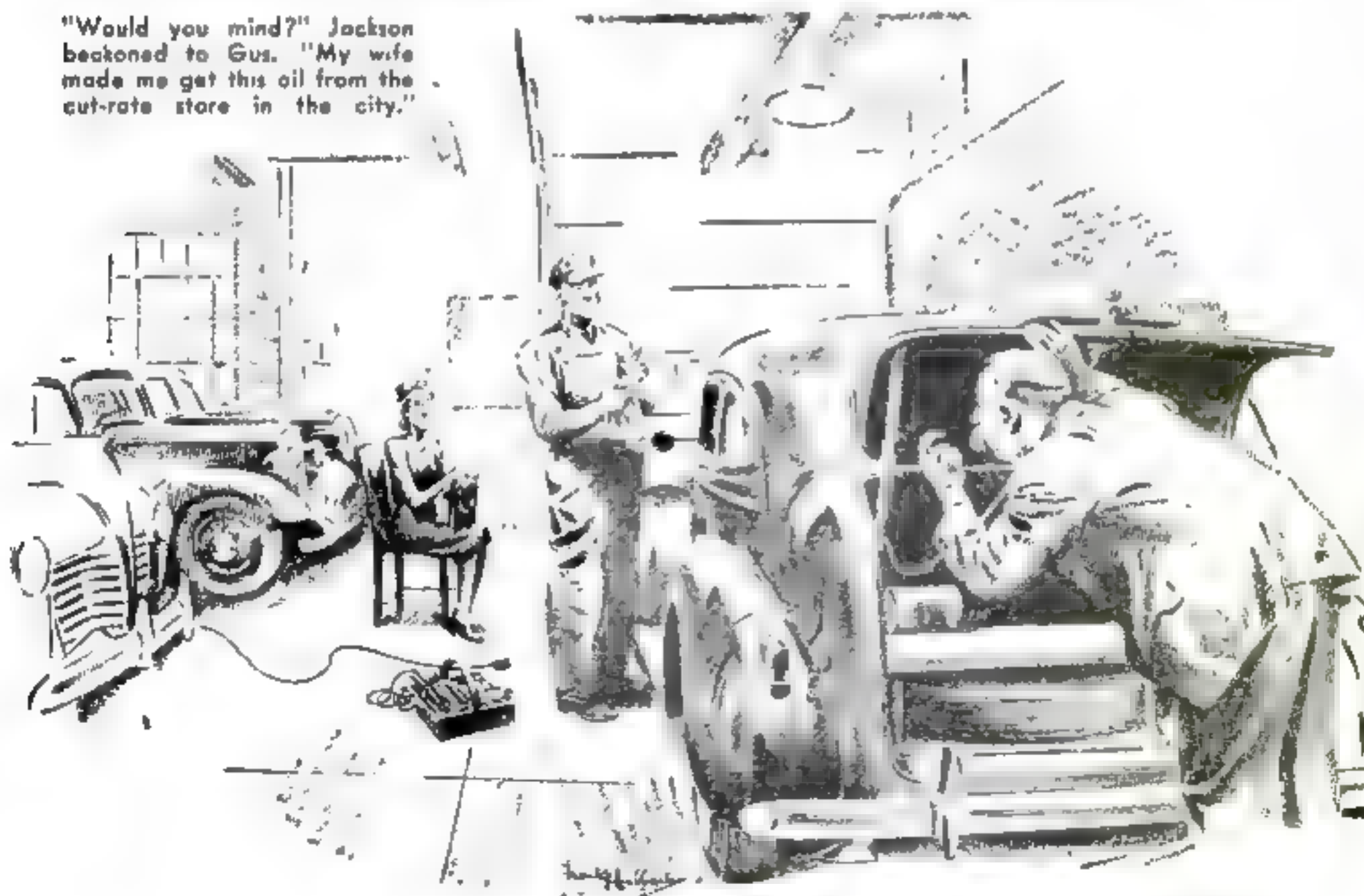
"I'll check your lighting circuit. Now, if the lady doesn't mind getting out—" Gus suggested politely. Mrs. Jackson, a grim-looking woman whose mouth turned down at the corners, descended from the car and plumped herself disapprovingly into the chair Gus brought for her.

The usual instrument tests showed no short circuit or ground, so Gus began to examine the wiring. "What's this extra wiring on the fuse block?" he called from the car.

"Oh, I did that," Jackson replied proudly. "I rigged up one of those automatic tilt switches that lights up the glove compartment when the door is opened. Did the same in the luggage compartment, so it lights up when the door's lifted. That was about a year ago."

"It looks okay," Gus said, "but *this* doesn't." He pointed to a frayed wire. "The

"Would you mind?" Jackson beckoned to Gus. "My wife made me get this oil from the cut-rate store in the city."



fuse clip has shaken loose and the wire here is bad. One of those loose strands could cause a short circuit and blow the fuse."

Gus tightened the fuse clip, re-soldered the lug on the wire, and was about to go on with his inspection. But Mrs. Jackson stopped him. "You've found what's wrong!" she snapped. "Don't try to find something else now to charge us for."

"I've found *one* thing that *might* have caused your fuse to blow," Gus told her. "There might be something else. But it's up to you to decide."

"I intend to!" Mrs. Jackson came back. "Hen-ree," she rasped, "tell the man to put some oil in—and make him use the oil we bought!"

Jackson's face by this time was a ripe tomato color. "Would you mind?" he beckoned to Gus. "My wife made me get this oil from the cut-rate store in the city today, and I forgot to put it in," he said, pointing to the can in the luggage compartment.

Gus laughed, took the can, and emptied it into the filler pipe. Mrs. Jackson put up a howl when Gus presented his moderate repair charge, and was still talking about it to her henpecked Henry as they drove out of the shop.

"For that poor fellow's sake," Gus thought as he prepared to close up for the night, "I hope I found what was really wrong in that lighting circuit."

APPARENTLY he had found what was wrong. The salesman came in next morning and got his car, but Gus didn't see anything of Henry Jackson for over a week.

Then about half-past nine one evening when Gus was again working alone in the shop, the door opened and Jackson came in. He was so excited he could hardly talk. "My l-lights again," he started to babble to Gus. "For a w-week they w-were all right and just now—th-they went out again!"

"Take it easy, Mr. Jackson," Gus said. "Why all the excitement?"

"Bu-but my w-wife," Henry stammered. "I'm on m-my way to pick her up in town. She wants me there at l-least 15 m-minutes ahead of time so there w-won't be any chance of her having to w-wait. W-waiting makes her n-n-nervous. If I don't hurry, I'm in for trouble."

"Drive your car in," Gus said. A glance told him that the fuse had blown out. Working fast, he checked the lighting circuit without finding anything wrong. When he

put in a new fuse, the lights burned brightly again.

Gus scratched his head. "Let's see," he said half aloud, "several times, but not always, when you've blown fuses it's been when you stopped suddenly. It could be the stop-light switch." But a quick check proved the stop-light switch was okay.

"Say mister, maybe I'd b-better take the car the w-way it is," Jackson said nervously. "Where I've got to p-p-pick up Mrs. Jackson is about t-ten blocks from here."

"The same thing might happen before you get there," Gus told him. "You've still got a few minutes." He scratched his head again. "Traffic lights—sudden starts—hills—well, no harm in trying."

Gus jumped into the car and drove out of the shop. In the driveway he stopped, then started off with a jerk. He heard a dull thud somewhere in the rear, and at the same instant the lights went out.

Gus backed into the shop, jumped out, and opened the luggage compartment. "I think we've found the troublemaker," he said, holding up a can of oil. "I'd lay a small bet you bought this in town today."

"Well, yes, so I did," Jackson admitted.

"And tonight your lights went bad again. You see, the can rolls around on the steel floor of your luggage compartment. When you go uphill or start up fast at a traffic light, it rolls to the back and touches the wiring of this automatic switch you installed. Months of that frayed the insulation, until a week ago the can finally touched bare wire and short-circuited the current to the steel floor. You didn't buy a new can until today, when the same thing happened."

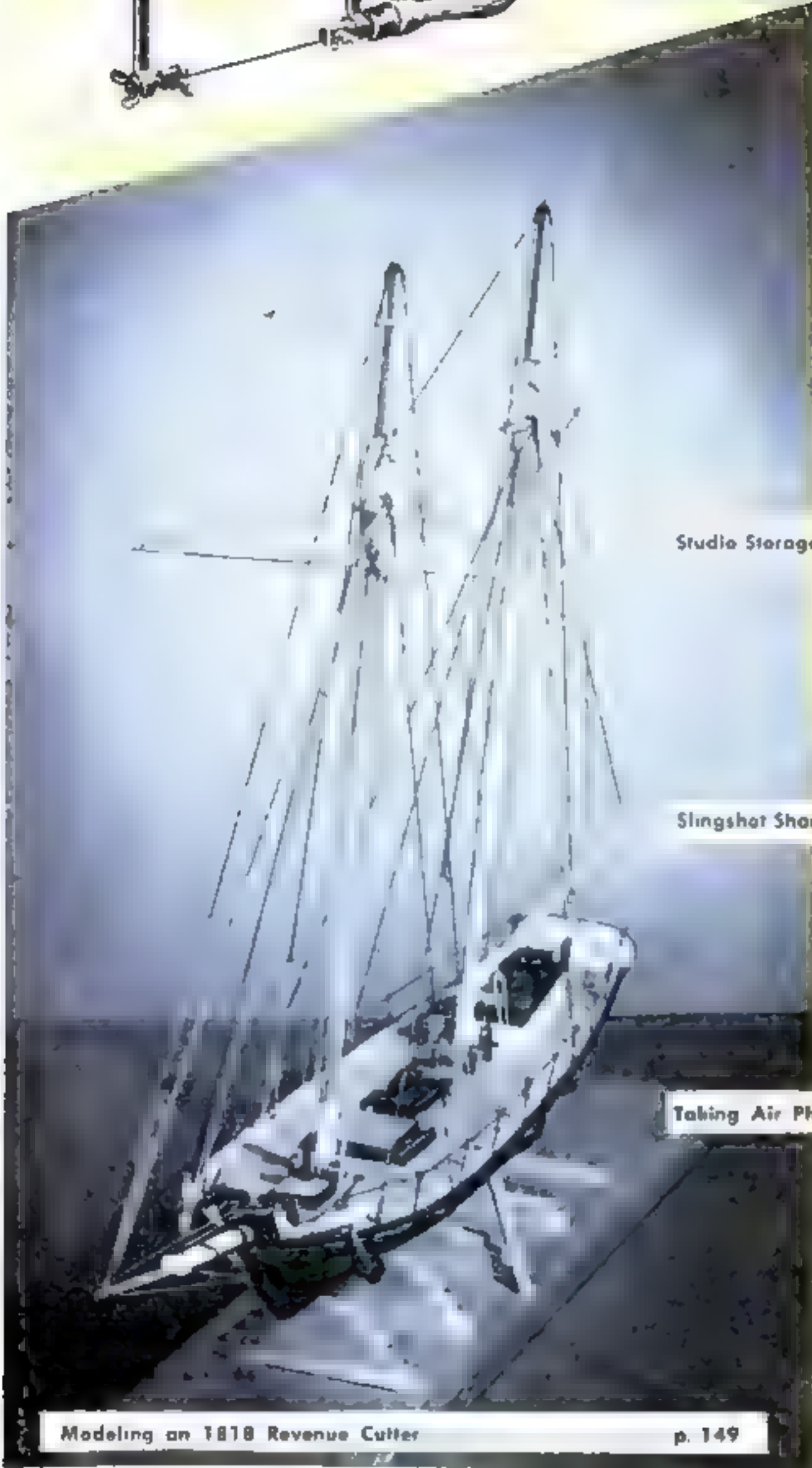
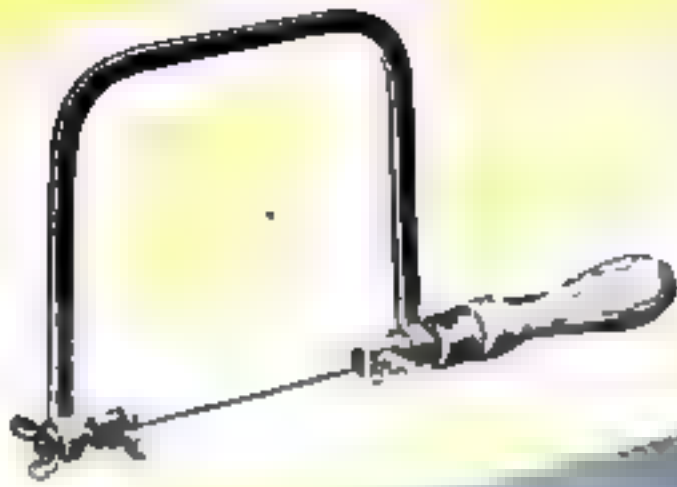
"By golly, Mister," said Jackson admiringly. "Wait till my wife hears this. Why—why, it's *her* fault if I'm late tonight!"

"So it is," Gus chuckled as he put in a new fuse. "You'd better tape up that wiring before you carry any more oil back there, if your wife insists you must."

"No sir, I don't think I'll let her, if she tries," declared Jackson, with an odd light in his eyes. "For years I've been careful to do things like she wanted them. It isn't the first time they haven't turned out right."

Gus closed the hood carefully. "You're all set now. Yes, I think you can say your wife's being extra careful about oil caused your grief." There was a meaningful twinkle in his eyes as he added: "That's not a bad thing to remember—being *too* careful can sometimes get you into trouble."

MECHANICS AND HANDICRAFT



Modeling an 1818 Revenue Cutter

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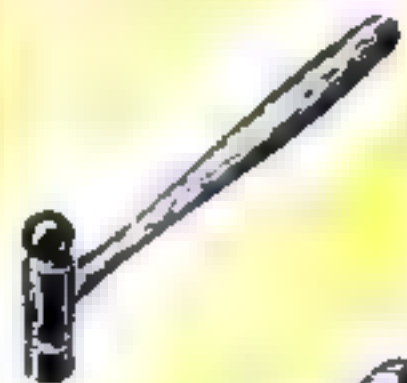
Studio Storage Couch

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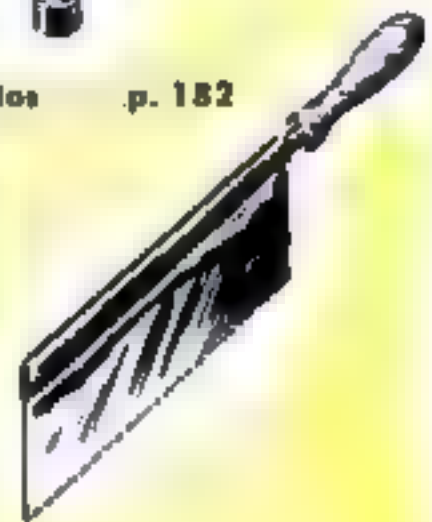
Slingshot Sharpshooter

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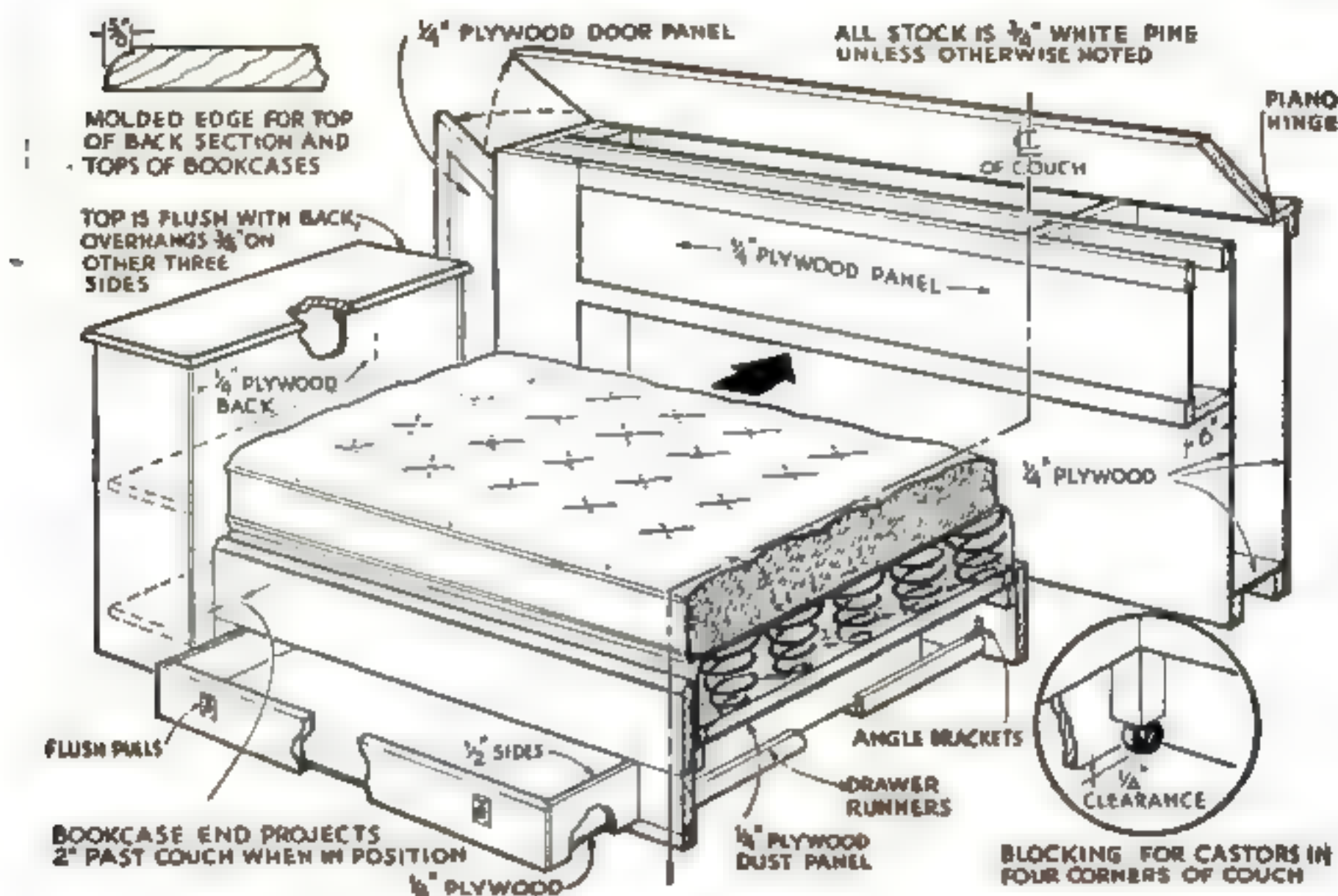


Taking Air Photos

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STUDIO COUCH *doubles as*

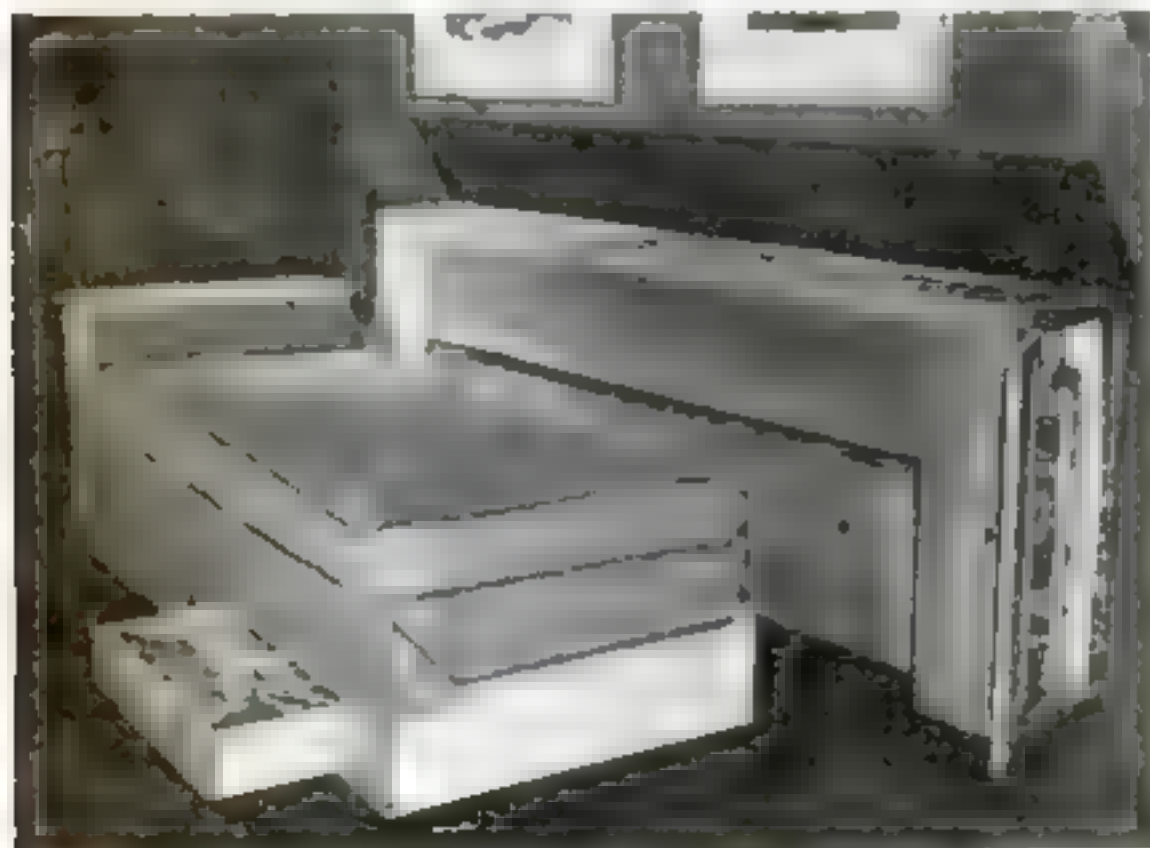


By HENRY R. DIAMOND

FURNITURE to serve more than one need has become recognized as a necessity in this day of small houses and small apartments. This studio couch, designed for use as a sofa and a bed, meets that requirement

in still other ways. Its paneled back provides storage for even large objects, its ends are bookcases, and it has two drawers under its springs. A combination unit of this kind, pictured in color on page 120, can be a boon for families doubling up during the housing shortage or for the householder with no extra room for an overnight guest.

Dimensions have been omitted from the drawing since, obviously, they must be suited to the couch at hand, which may be an ordinary studio couch with the legs sawed off or a full-size single box spring and matching mattress. When used as a sofa, the spring unit is partly under the overhang of the back, with width thus cut to that of the average sofa for greater comfort. At times it is to serve as a bed, it is pulled out into the room. Casters under the four corners will make handling easy; if the couch shows a tendency to roll out when someone leans against the



Pulled out from the back, the couch makes a comfortably wide bed.

multiple storage unit

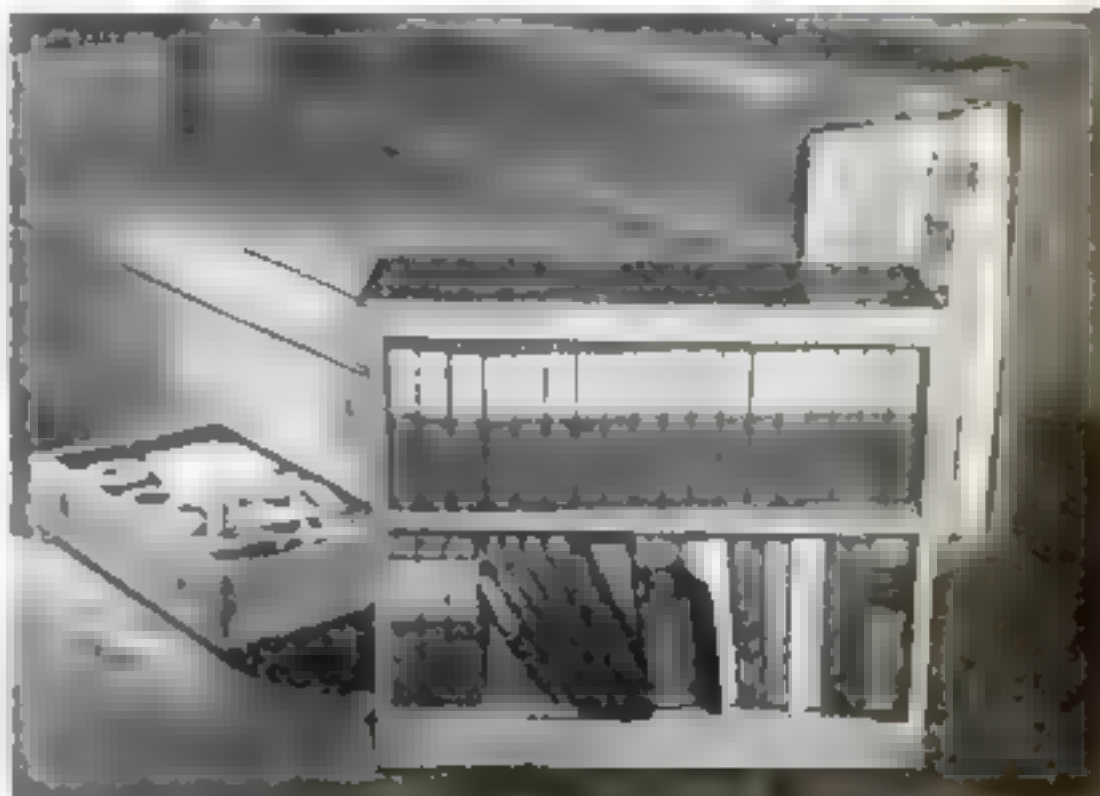


back, a pair of concealed screw hooks will hold it in. The distance from the floor to the bottom of the overhang on the back should just allow the couch to slide in place. The length of the back is that of the couch plus the two bookcase depths.

Storage space should be designed to fit needs, with the deep compartment large enough for a card table, game boards, and the like, and possibly even for folding card-table chairs. Smaller things may be kept conveniently at hand in the overhanging bin, and writing materials and the like in the shallow drawers. Doors at both ends of the back unit and a hinged lid provide easy access to its contents. Piano hinges set flush are ideal for long lids of the kind shown, but if they are not readily available, four ordinary butt hinges may be found a satisfactory substitute. The lid may also be divided at the center and three hinges used on each section. A

treatment of this kind permits use of half as a shelf while the other half is raised.

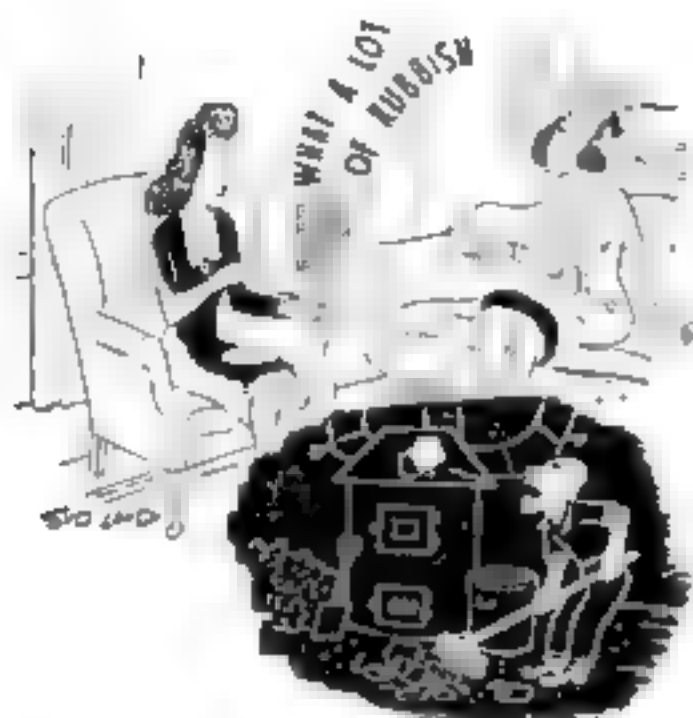
Materials required for construction are $\frac{3}{4}$ " white pine and $\frac{3}{4}$ " plywood, some of which may be used in scrap sizes. Stain and varnish to blend with other furniture, and then wax to a satiny finish.



The ends hold books; the drawers and back, frequently used items.

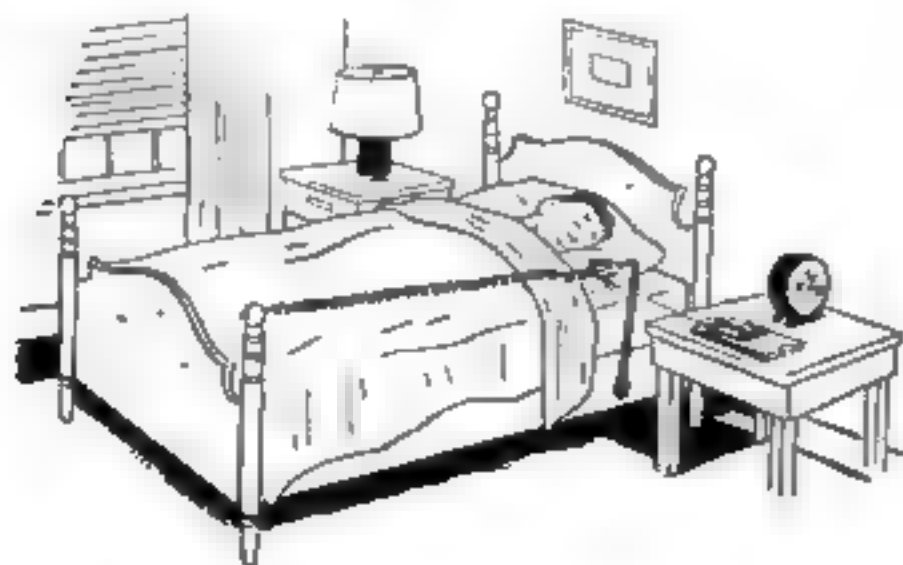
What's Your Ingenuity Quotient?

Have you pulled off a smart one lately? We will pay for each contribution accepted for this page showing ingenious solutions of problems in the home, shop, garage, or camp. It doesn't matter if it's wacky—if it works.



HOT AIR travels both ways in my house via this furnace intercom. From down in my cellar workshop, I can talk to my wife anywhere upstairs through a small hole in the furnace jacket. A screw-pivoted plate serves as a cover.—**RUSSEL C. REICHARD.**

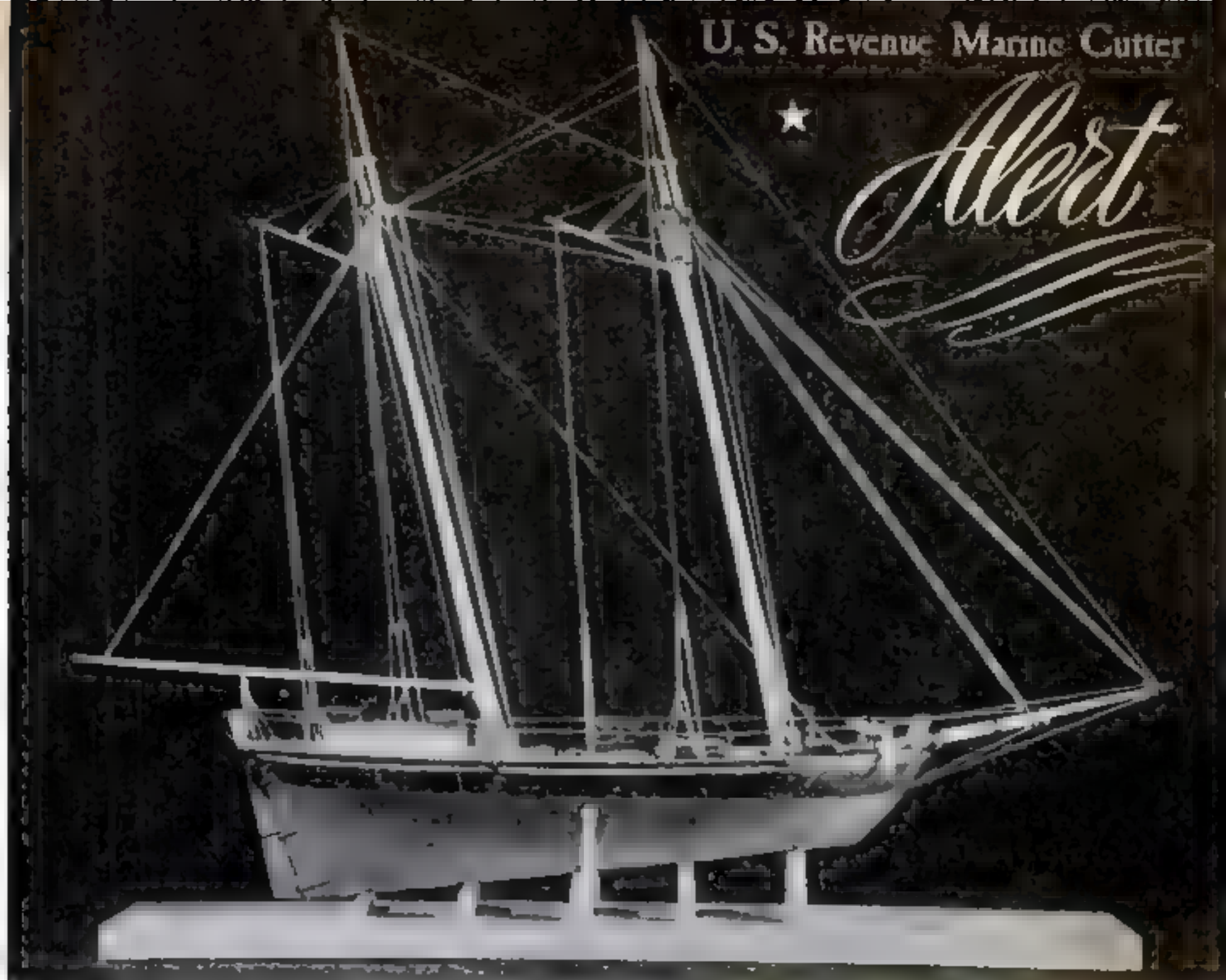
LIKE MUSIC IN A DREAM, jangling alarms only sing me to sleep. My automatic getter-upper is another story. The alarm key trips a rat trap which frees a spring that yanks the covers off—leaving me nothing to do but get up.—**JACK SKILES.**



IT'S PLANE COMMON SENSE to do two jobs at once. Having to chamfer two edges of several hundred 2" by 12" planks, I joined two 14" planes with C-clamps and an aluminum angle, and did the two edges at one time. Now it takes all my will power to keep away from my mahogany banisters and railings.—**S. FENSTER.**



CAN'T BE BOTHERED putting caps back on toothpaste tubes? Neither could I, but this cap does it with no bother at all. A slight squeeze forces up the spring, and the paste comes oozing out. When pressure is removed, the gate slides back, cutting off the supply, sealing the tube, keeping the paste fresh.—**PAUL ZIGALO.**



A RAKISH COAST GUARD VESSEL OF 1818

By Frederick Aeschbacher

PART I

WHEN Alexander Hamilton conceived a plan for a marine patrol service to assist in the enforcement of the nation's first revenue law, he wrote the opening page in the long and adventurous history of the United States Coast Guard. The Revenue Marine, as it was then called, was created by act of the first Congress, and approved by President Washington on August 4, 1790.

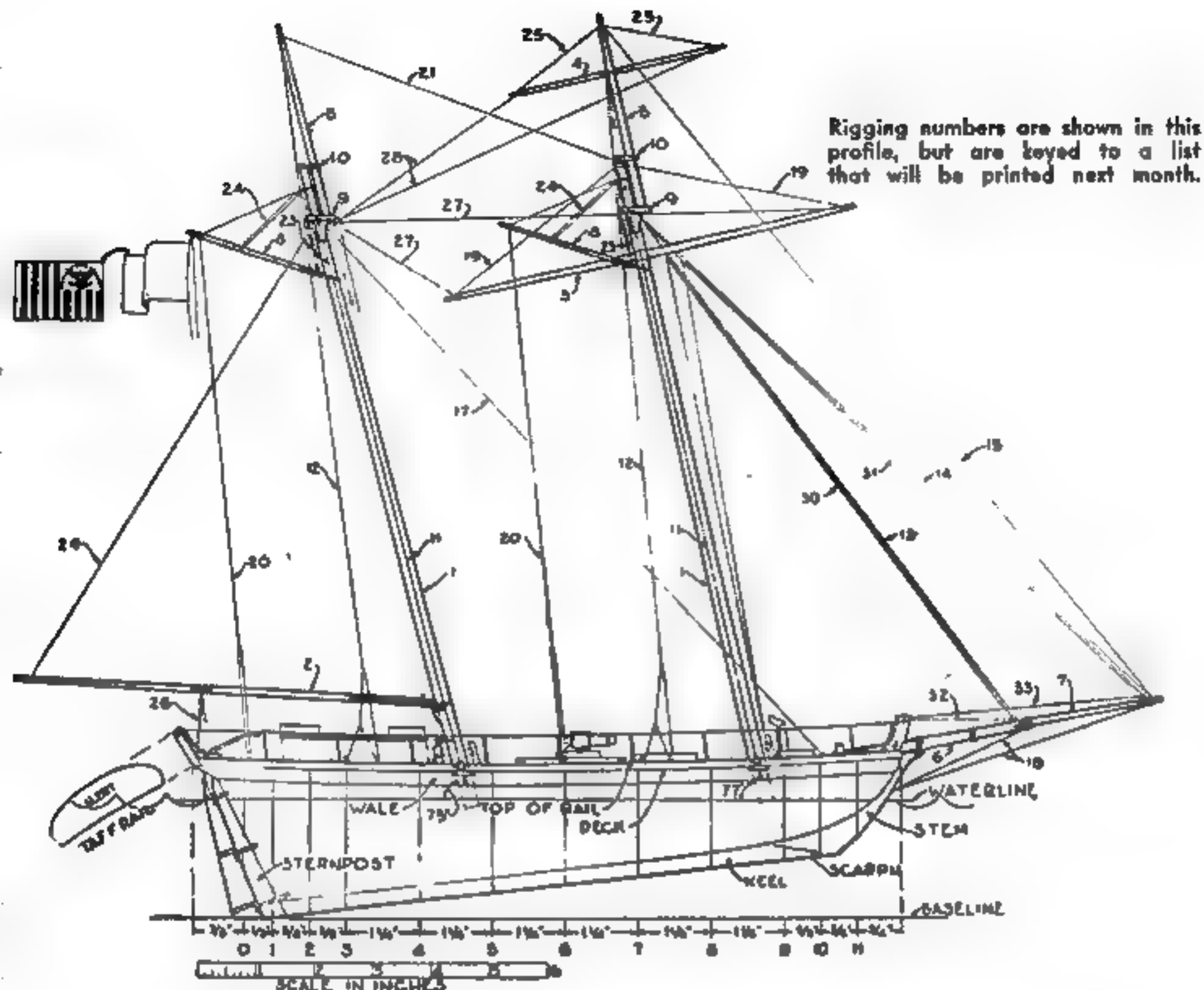
Little is now known of the earliest ships built for the service, but in 1815 William Doughty, a naval constructor, designed three new classes of cutters. One of the smallest, commissioned in 1818, was a 31-ton craft measuring 48'6" on deck, 14'9" beam, and 5'0" depth of hold. With a large sail area in

a topsail schooner rig, and fine hull lines, it evidently was a speedy craft. Its armament consisted of one 18-lb. carronade.

The evidence seems to indicate that the prototype of the scale model shown above was named *Alert*. Plans were drawn from *The History of American Sailing Ships*, by Howard I. Chapelle, published by W. W. Norton & Co.

Since the original vessel was quite small, the comparatively large scale to which the model is built ($\frac{1}{2}$ " equals 1') makes it possible to work in considerable detail. The absence of bulwarks and simplicity of rig will appeal to the beginner, the rakish appearance to the experienced craftsman.

For the hull, use a piece of pine or other clear, straight-grained wood dressed to $2\frac{1}{2}$ " by $3\frac{1}{2}$ " by $12\frac{1}{2}$ " to allow for final shaping. On



one of the wider surfaces and from it all around the block, draw an exact centerline. At right angles to the centerline draw station lines 0 to 11 as in the illustration above. The contour at these stations is given on the facing page.

Transfer a drawing of the half-breadth plan to the block to outline the deck, making sure that the center and station lines coincide. Draw the waterline all around the hull, $\frac{1}{8}$ " below the rail. Lay off the slope of the rabbet line, which represents the bottom of the hull proper, and saw off the waste, allowing a little extra for shaping. Redraw the centerline and two parallel lines $\frac{1}{16}$ " on each side of it along the bottom. This gives a $\frac{1}{8}$ " flat surface to which the keel will be attached. With a square, replace the station lines. Finally, trace the actual-size contour templates shown on page 151 onto stiff cardboard, marking on them the rabbet, waterline, and top of rail. From the hull proper, scale up templates of the stem and stern. A

block may be screwed to the deck so that the screw holes will later be covered by the cabin trunk and main hatch, and the hull then clamped in a vise for shaping.

Shave away the excess material from the middle to the ends. Try the templates from time to time. Leave the $\frac{1}{8}$ " flat on the bottom until the keel and sternpost have been attached, and then shape it to the proper curve.

From the hull profile, lay out the top of the rail, make a few shallow saw cuts, and chisel down to the deck. Alternatively the hull may first be carved to the deck line and the rail steamed to shape and glued on as a separate piece. It is $\frac{1}{8}$ " high and $\frac{3}{32}$ " thick. The deck camber, which is $\frac{3}{16}$ " in $\frac{3}{4}$ " width, should be worked out before or during the carving of the rail.

The actual wale was a couple of strakes of thicker planking just below the deck. A simple way to show it is to scribe a line $\frac{1}{32}$ " deep the length of the hull $\frac{1}{8}$ " below

the top of the rail, and then to cut back the hull from below up to the line on a shallow slope, removing a wedgelike chip $1/32''$ deep at the line and fairing into the hull below. Fair out the groove so formed at the counter and stem.

Drill the holes for the masts next. With reference to the waterline, foremast and mainmast rake aft 77° and 75° respectively. Spot their centers carefully, and drill $1/8''$ holes $1/2''$ deep. Stem, keel, and sternpost, all $1/8''$ thick, go on next; the first two are step-joined as shown in the profile. The hawse timbers, $3/32''$ thick, are set on the forward rail, and follow the curve of the hull in plan and profile. The $1/8''$ hawse holes are parallel to the hull centerline.

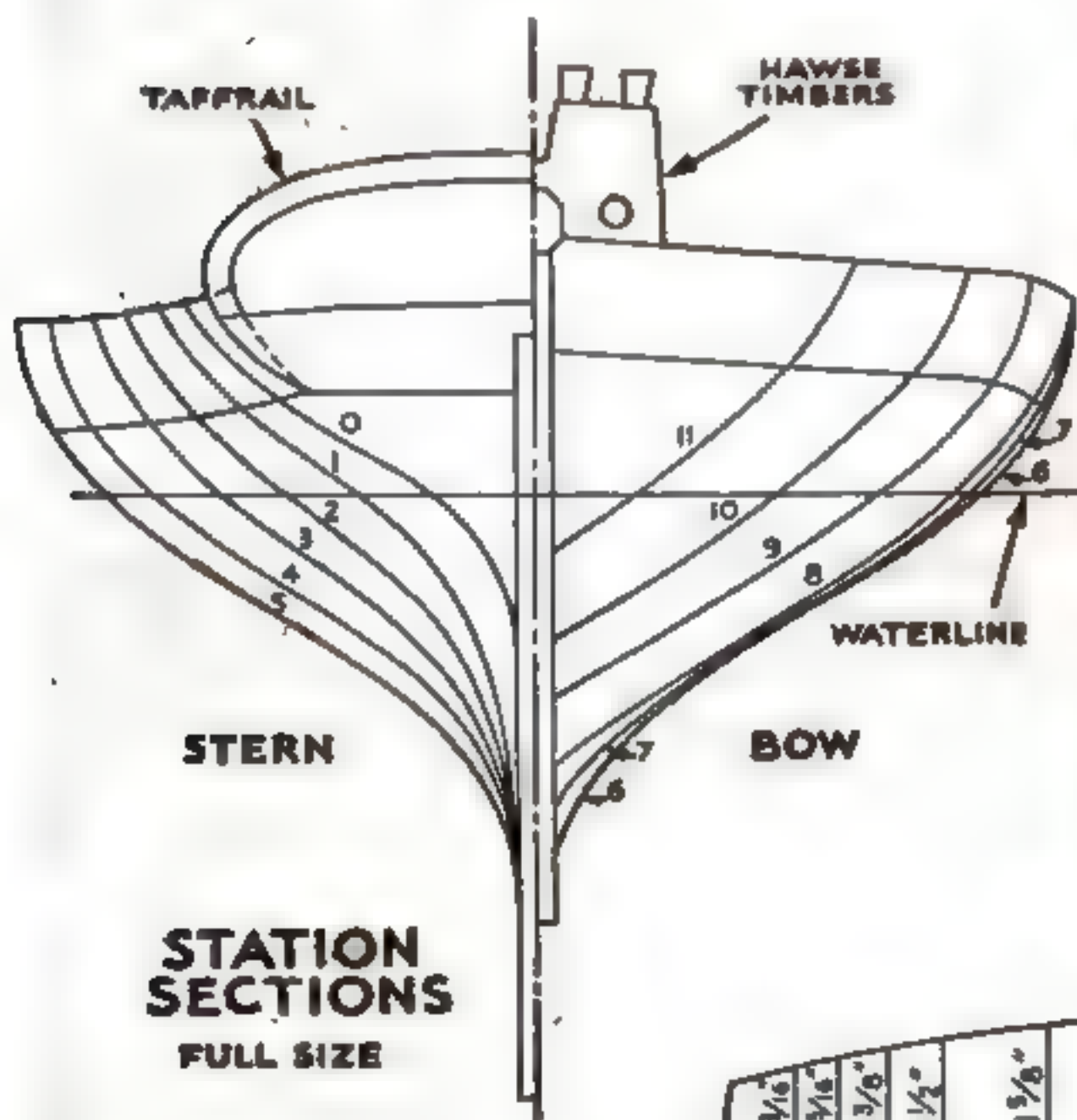
A half plan of the taffrail is shown in the section view below. Carve it from $1/4''$ by $13/16''$ by $2\ 5/16''$ pine, beveling the top and bottom and shaping it to fit the deck camber. Hollow the taffrail slightly, forward and aft, leaving a band around the edge at the back as shown in the photo below. Notch

it to fit over the rail, and add fairing pieces.

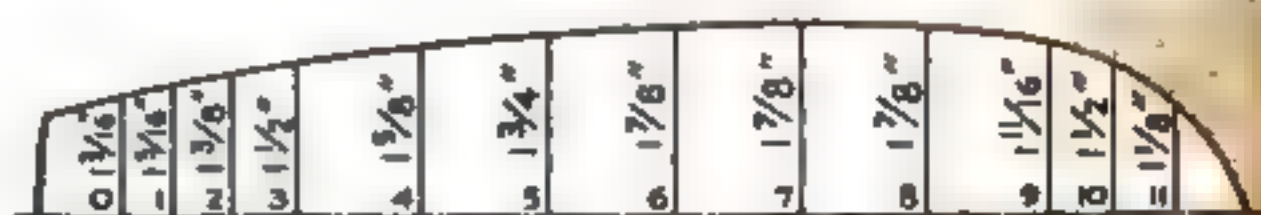
The hull is now almost complete. Sand it smooth, and you are ready to draw the decking. With a hard, fine pencil, make a line $1/8''$ inside the rail and parallel to it to represent the plank-sheer. Starting from the centerline, draw lines $3/32''$ apart the length of the deck. Do not overrun the plank-sheer lines.

Coach paints, ground in japan, are good for finishing the model. Use black from the waterline up to, and including, the top of the rail. Everything below the waterline is painted brown. A sharp division between the colors can be obtained with the help of masking tape. Paint a red stripe $1/16''$ wide from the stem to the fairing piece below the taffrail. The top of the stripe is $1/8''$ below the top of the rail.

White paint is used for the inside of the rail, taffrail, and hawse timbers, and the deck is finished with two coats of clear varnish thinned with turpentine. Details of fittings and rigging will be given in the concluding installment, next month.



**STATION
SECTIONS
FULL SIZE**



HALF BREADTH



THE WORKSHOP MAGIC BUILT

LAMPS and cabinets made in the barn-workshop of a Michigan country home look like the product of any good craftsman—until you discover that the lamps can materialize from space and the cabinets cause pretty girls to vanish on command. For in this workshop Harry Blackstone constructs the tricks that mystify his audiences.

Blackstone, who got an early training as a magician while operating a lathe for a manufacturer of magic tricks, makes his own apparatus. Using power and hand tools common to most well-equipped home workshops, he builds cleverly hidden gimmicks to work all the magic art he displays to audiences. For trouble-free operation, parts must be made to close tolerances.—K. M.

Dimensions of this cabinet must be exact to make the magician's assistant disappear on schedule.



On a bandsaw, Blackstone cuts intricate metal parts for his stage apparatus. Careful workmanship on details like these assures smooth performance.



This table lamp, complete with bulb alight, appears mysteriously on an empty tray as Blackstone waves his hand—and his stage assistant pushes a button concealed on the tray.

Apparatus constructed by Blackstone in his home workshop is used for the Hindu rope trick. A rope rises into the air and is climbed by a boy who suddenly vanishes when the magician fires a pistol.

Quilted Vanity Chest from Cigar-Box Wood



Built with simple butt joints, the chest is covered with quilting as a distinctive touch.

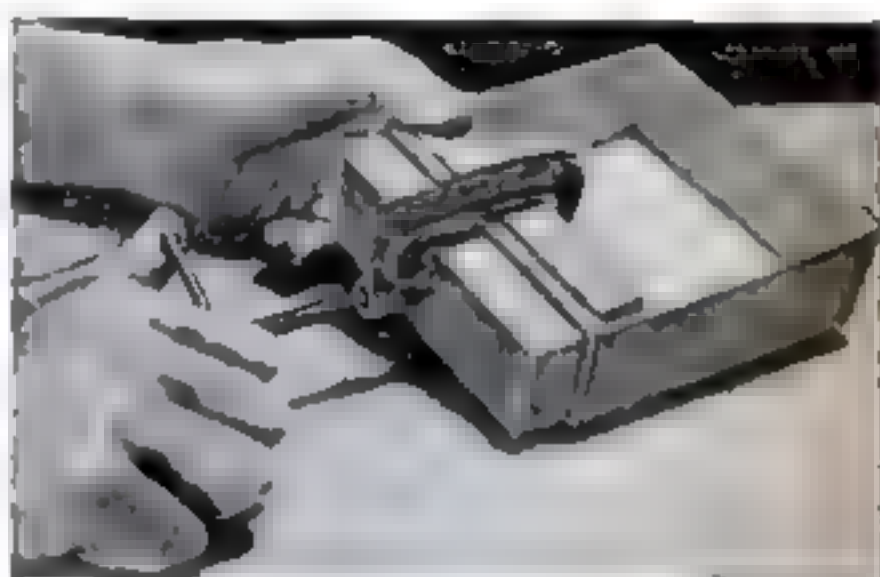
By CHARLES and BERTRAM BROWNOLD

THIS little chest is made of any $\frac{3}{4}$ " stock such as cigar-box wood. The top, bottom, and two drawer guides measure $4\frac{1}{2}$ " by 5", the sides 5" by $5\frac{1}{4}$ ", and the back 5" by $5\frac{1}{4}$ ". All three drawers are $1\frac{1}{2}$ " deep, $4\frac{1}{2}$ " wide, and 5" long. Use small box nails, and sand the drawers until they slide easily. The quilted material with which the chest is covered is carried by many department stores. A quarter of a yard is enough for the job with a little left over for possible trial and error.



1. Cut cardboard backing strips the same size as the drawer fronts, cut the quilting a little large, and snip off the corners. Then fold over the edges and glue them to the backing strips.

3. Use one long cardboard backing strip and one piece of quilting for the two sides and top. In gluing, clamp one side first, draw the quilted strip over tightly, and clamp the second side.



2. Apply a thin, even glue coat, put a quilted strip in place, and clamp between two blocks. If any of the glue squeezes out, wipe it off with a damp cloth before it has a chance to set.

4. A square, quilted backing strip may be glued to the back under the weight of books. Drawer pulls are cheap hotpins cut short, inserted in drilled holes, and bent over on the inside.



Rubber-Band Sharpshooter



How a North Carolina Sportsman Makes and Shoots His Slingshots

ONE OF boyhood's traditional toys has come of age. Jim Gasque, North Carolina sportsman, has proved that the ordinary slingshot, when properly made and used, can be an adult weapon of deadly accuracy at distances up to 30'—a range sufficient for stalking small game. He shoots regular No. 0 buckshot.

His slingshots are made as shown, the dogwood forks being dried in a slow oven

overnight after tying. Instead of inner-tube strips, he uses two rubber bands $1/16$ " thick, $3/8$ " wide, and $7\frac{1}{2}$ " or 8" long.

When shooting, he takes a stance similar to that in archery, body at right angles to the target, feet apart, and weight balanced on both feet. Holding the shot cup at the right eye, he stretches the rubber by extending his left arm fully while aligning the target in the sights.—TOM CUSHING.

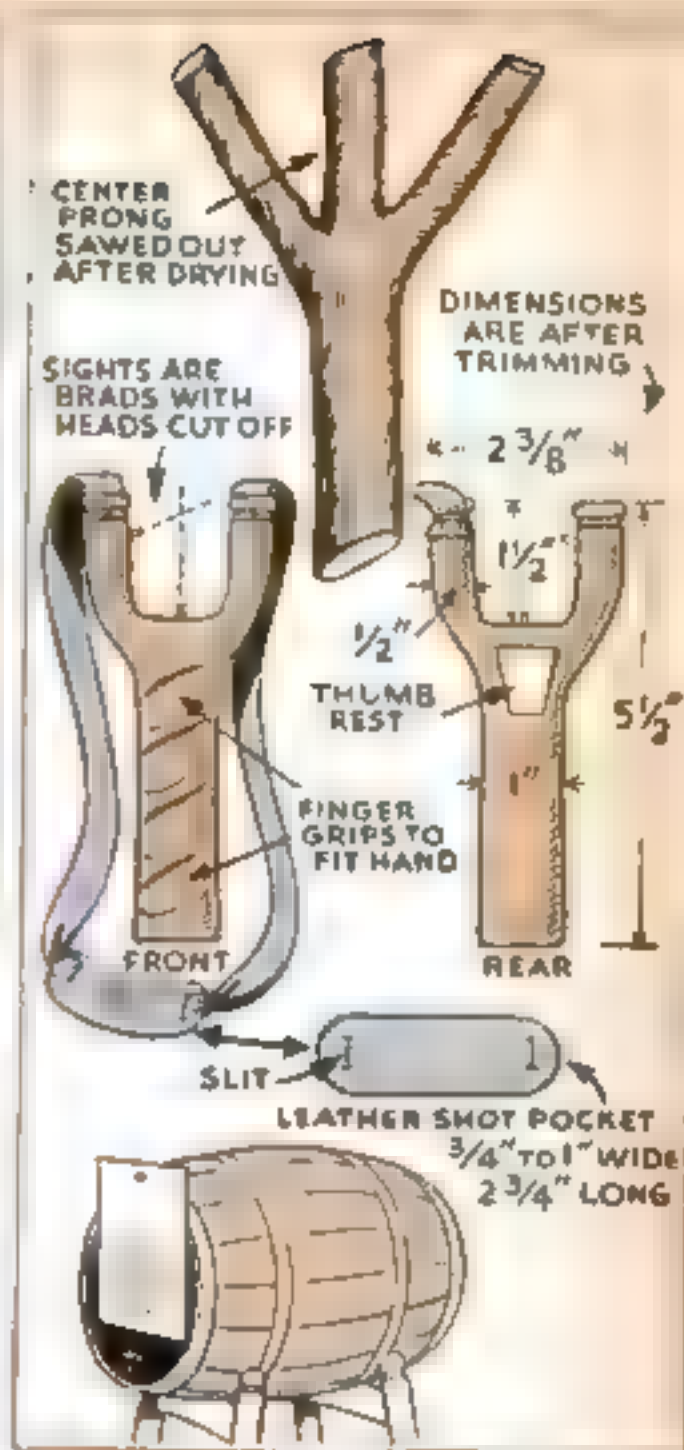
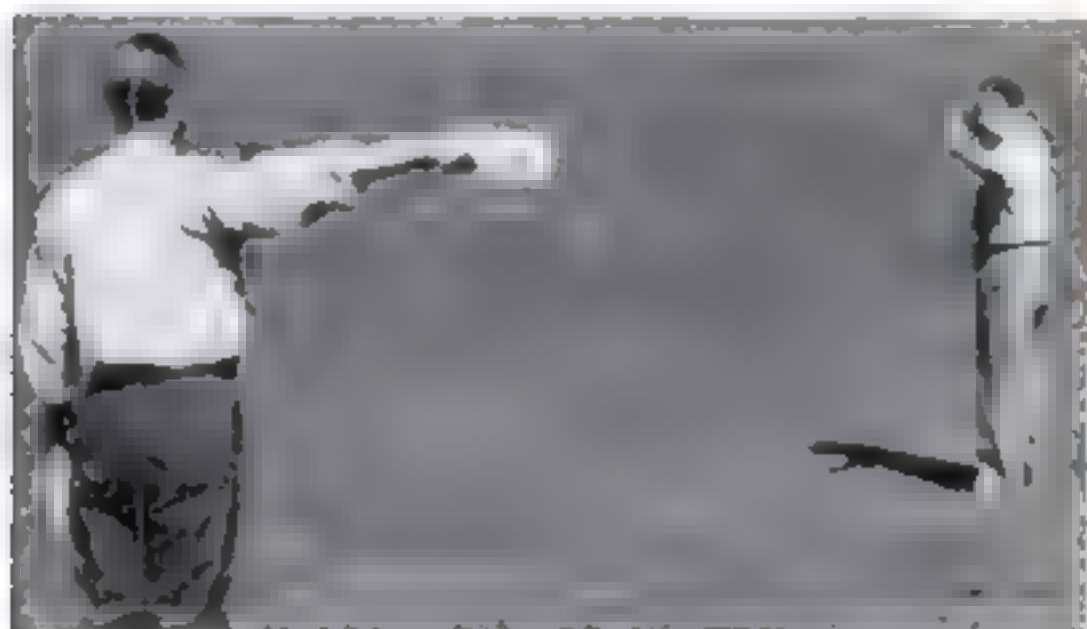


Beginning with a three-pronged dogwood fork, Jim Gasque makes a slingshot by drawing in both outer branches and tying them to the middle prong. When dry, the fork retains this U-shape and the center stem is cut off.

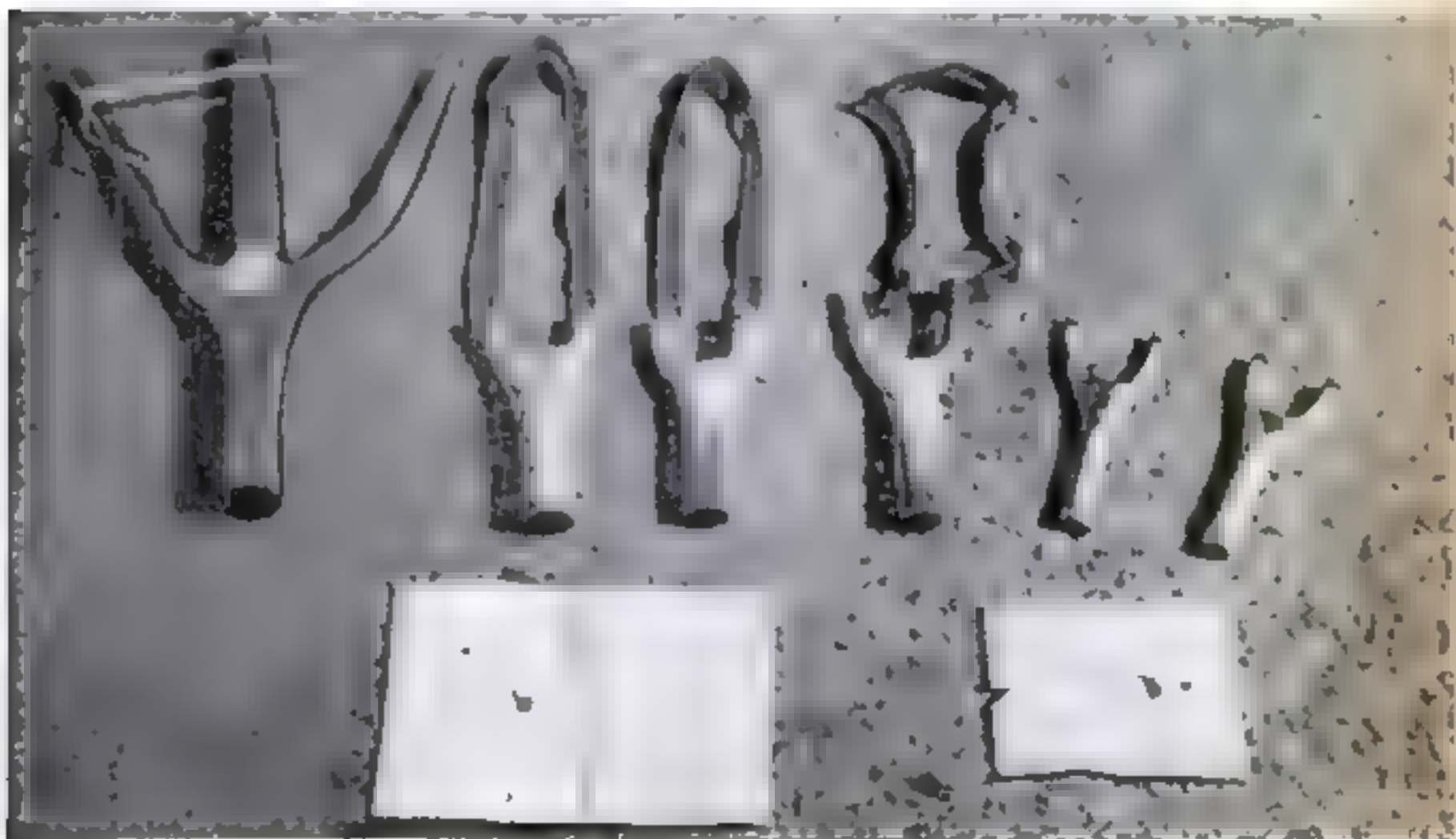
Tied for drying, this dogwood fork eventually will become a part of the slingshot arsenal at the right. Two used targets with bull's-eyes the size of a quarter show the accuracy that is possible at ranges up to 30'.

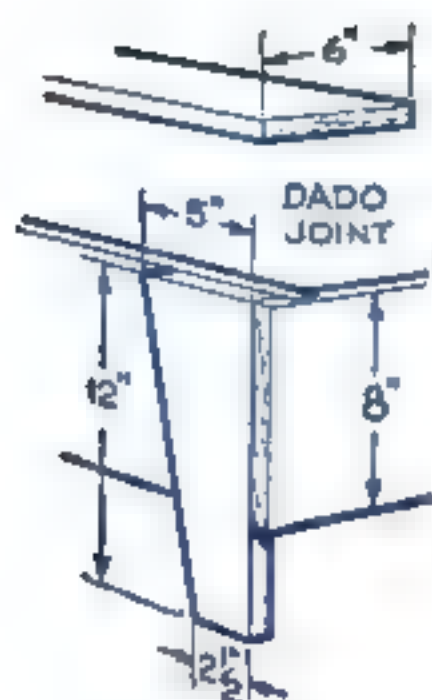


Deadly accuracy is attained by holding the shot cup at eye level and lining up the target at the intersection of the sight lines.

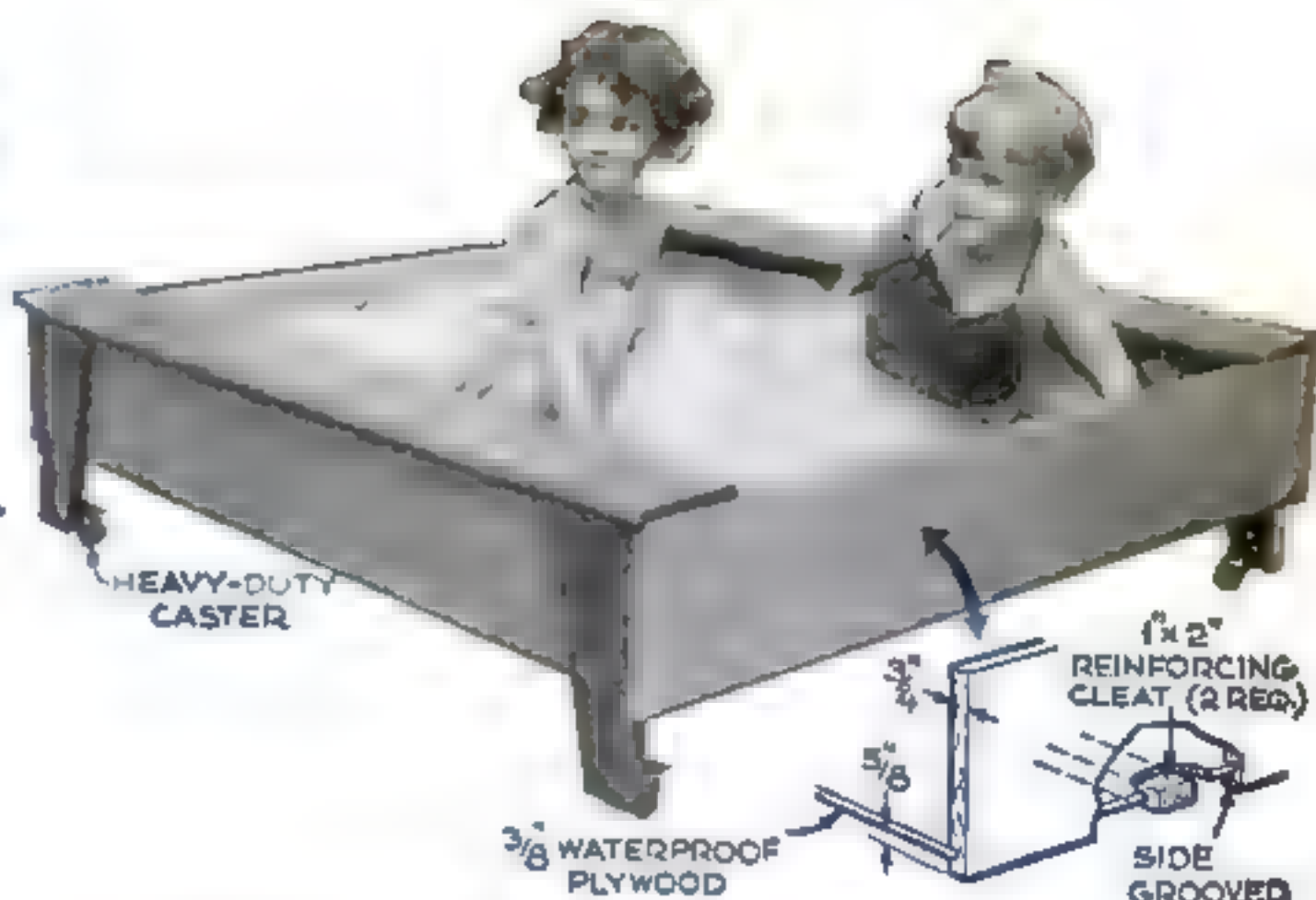


For target practice in the basement, a leg may be placed atop two chairs, as above. An old pillow inside keeps the shot from being deformed





Corner Detail



Wading Pool for Back-Yard Use

HOT summer days will make a back yard equipped with a wading pool a welcome spot. The pool shown here is built around a standard 4' by 4' sheet of $\frac{3}{8}$ " waterproof plywood, which is dadoed into the sides, as shown in the detail at right, to serve as the bottom. Two 1" by 2" cleats help reinforce the bottom.

A corner detail is also shown in a drawing, with dado joints that help make the box leakproof. Assemble the bottom, sides,

and legs with well-spaced nails and plenty of waterproof glue, and then glue and nail on the end seats.

If wide, heavy-duty casters are used, the pool can be moved without difficulty on paved surfaces. However, small doughnut-type tires may be needed on lawns. A 1" hole bored in a corner of the plywood bottom and corked will serve as a drain.

Paint with a good grade of waterproof enamel in bright, contrasting colors. A final coat of spar varnish will preserve the finish.—HARRISON NEUSTADT.



Hot-Dog Roaster Bent of Wire

SCRAPED coat-hanger wire doubled and shaped to have a ring at one end will hold wieners for roasting outdoors. Grind points, push them through the wieners, and slip the ring over a fresh-cut stake driven by the fire. The stake should be big enough to give the ring some purchase.—G. E. H.

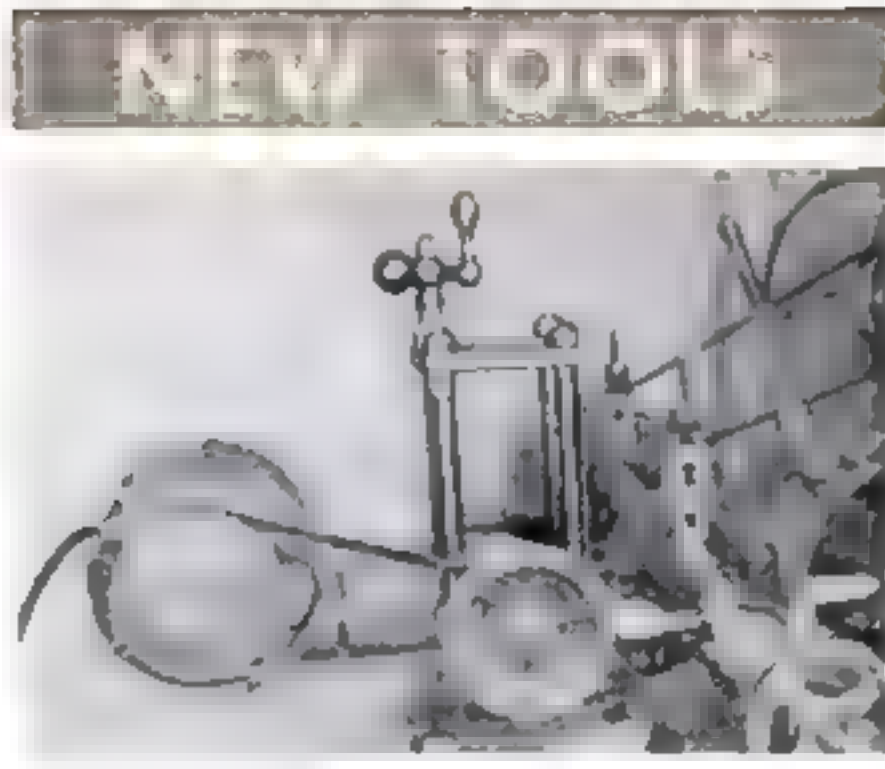
Reel from Typewriter Spool

MOUNTED on a bamboo fishing pole with a small bolt through a drilled hole, a ribbon spool becomes a satisfactory reel. Drill out the center of the spool, if necessary. Use a wing nut so tension can be regulated. Bolt a wood knob near the spool edge for a handle.—HARRY F. LEEPER.





MANY EXTRA LATHE JOBS are performed with a new universal power unit having interchangeable heads for milling, grinding, drilling, boring, and keyseating. The tool is shown at left above with a high-speed milling and drilling head set up for radial drill-



ing after a circular T-slot has been cut in the workpiece. At right, the milling unit end-mills a keyway in a shaft held between lathe centers. The new lathe accessory is a product of the Master Manufacturing Company, of Hutchinson, Kan.

SOLDERLESS WIRING can be done quickly without experience with the aid of a tool used like pliers to cut and strip wire and to



crimp on terminals. It is made by Aircraft-Marine Products, Inc., of Harrisburg, Pa., and is available in a kit that contains a number of terminals in a variety of sizes and types for repairs and new wiring. Insulation-stripping holes along the handle shanks will fit several standard sizes of wire.



A SPRAY OR STREAM is obtained with a change of nozzles on a new plastic-body oil can put on the market by the Midwest Production Machine Company, of Columbus, Ohio. A finger-operated pump provides an easily controlled way of delivering the lubricant. The transparent Tenite barrel gives visual evidence when the $\frac{1}{2}$ -pt. oil supply is running low.



NEW PRECISION ACCESSORIES now make the Handee portable electric rotary tool adaptable for a variety of additional operations. The Chicago Wheel & Manufacturing Co., maker of the Handee tool, announces a curved carving index, straightedge ruler, compass depth gauge, router shoe, molding shoe, and holding fixture.

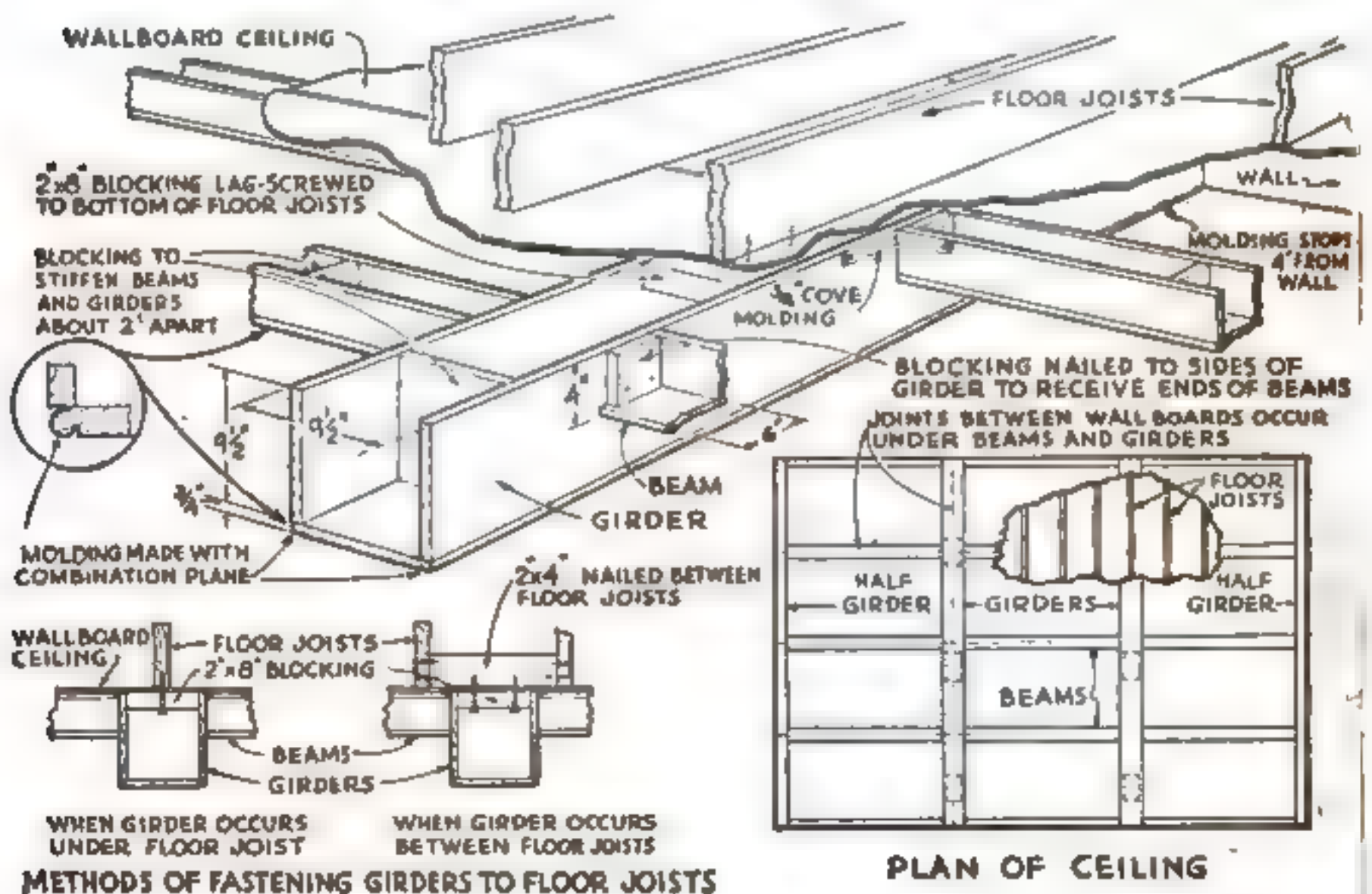


Beamed Ceiling Built Up of Common Lumber and Wallboard

IN A period room where a beamed ceiling is required, the beams can be made up of $\frac{3}{4}$ " white pine at great saving in both cost and weight. Such beams can be installed at any time in a finished house. It is often practical, however, to wait until the original plaster ceiling is in need of repair, for then the plaster and laths can be pulled down with little loss and wallboard or similar

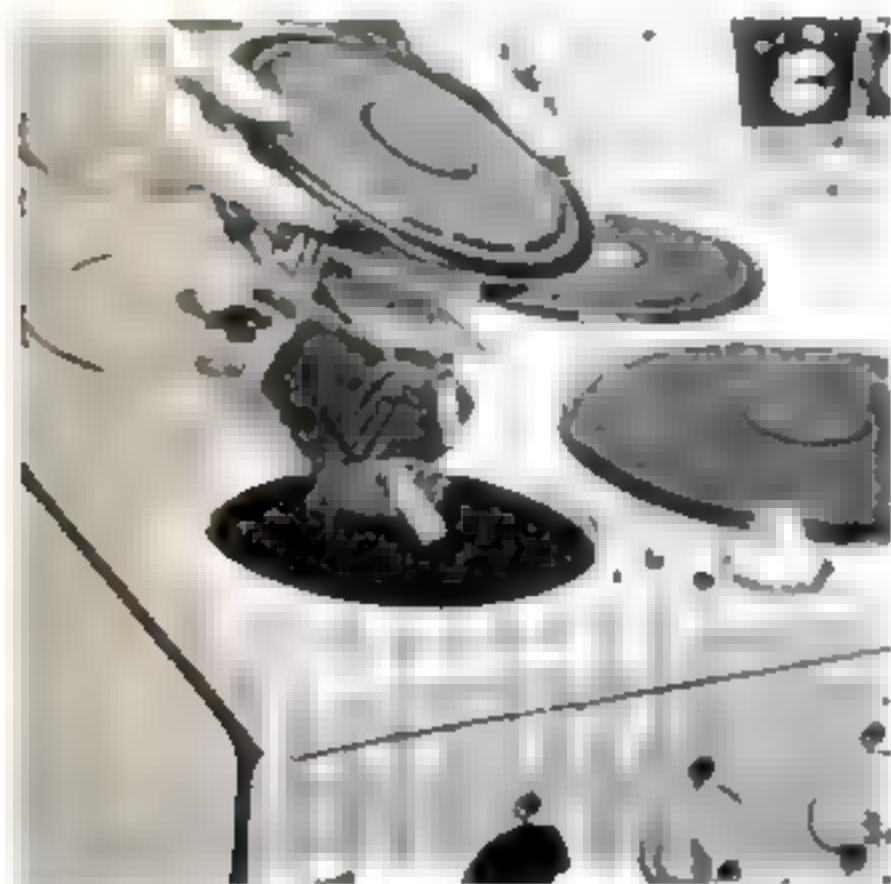
sheets substituted for them. This exposes the joists and permits laying out the beams so they can be easily nailed on with blocks in one of the two methods shown below.

Arrange the wallboard so the beams will conceal the joints, as indicated. Both the pine beams and wallboard take any of a variety of finishes from paints and enamels to stains and varnish.—H. R. D.





TOY ELECTRIC ORGANS with full, true tones are being made by the Electoy Division of Electronic Laboratories, Inc., of Indianapolis. They look like portable typewriters, have keys like a piano, and play and sound like a real organ. Though introduced as a toy, the new musical instruments will probably find favor with adults as well.



THERMOSTATIC CONTROL for stove-top cooking on electric ranges is offered by the Proctor Electric Company, of Philadelphia, in a new electric heating unit shown in the photo at the left. The thermostat is marked with warming, boiling, and frying zones, and it may be set for tepid heat, simmering, slow or hard boiling, and any desired frying heat. If a saucepan boils dry and begins to overheat, current is turned down automatically, thus saving the food and the pot as well.

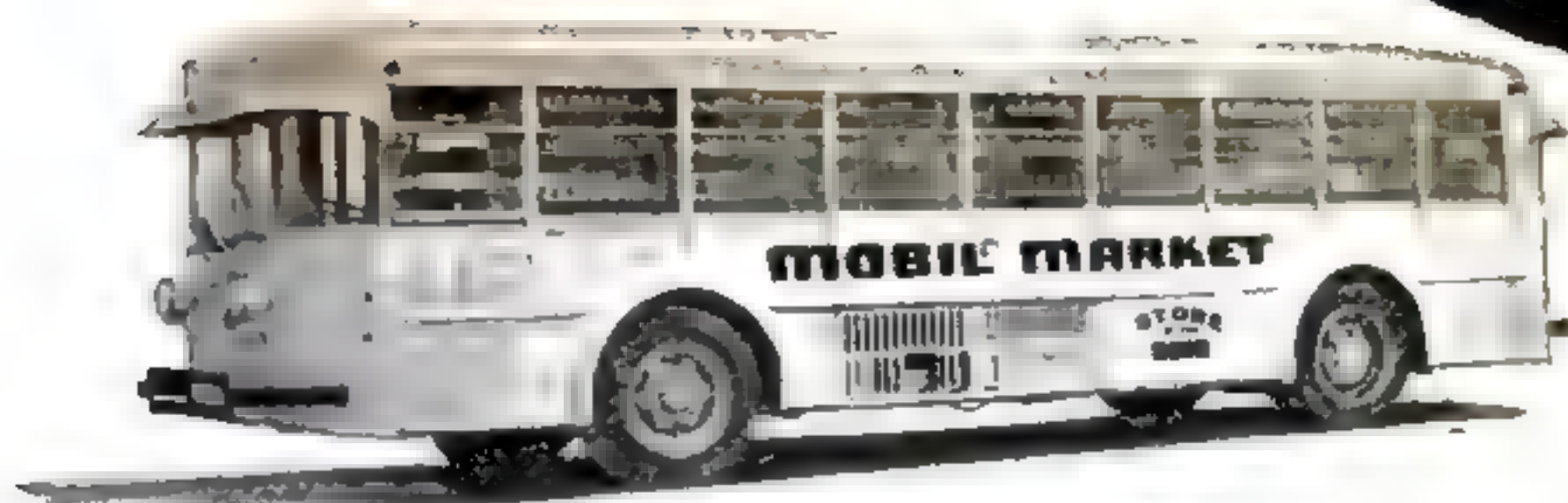
The heating coil is embedded in a heat-conductive cement ring that can be wiped clean with a damp cloth.

AUTOMATIC FEEDING of a baby is taken care of with a bottle holder that can be hung on the crib or carriage. The holder, made of washable cloth, also helps keep the bottle warm. It is made by Heide Babe Products, of Chicago.



INSTANT STARTING is provided with a new fluorescent lamp being manufactured by Sylvania Electric Products, Inc., of Salem, Mass., for operation in a two-lamp compensated-ballast circuit. An invisible coating protects the lamp against humidity—a cause of bad starting. The photo shows an untreated lamp, at top, covered by a film of water after spraying and a treated lamp on which the water has collected only in a few isolated drops.

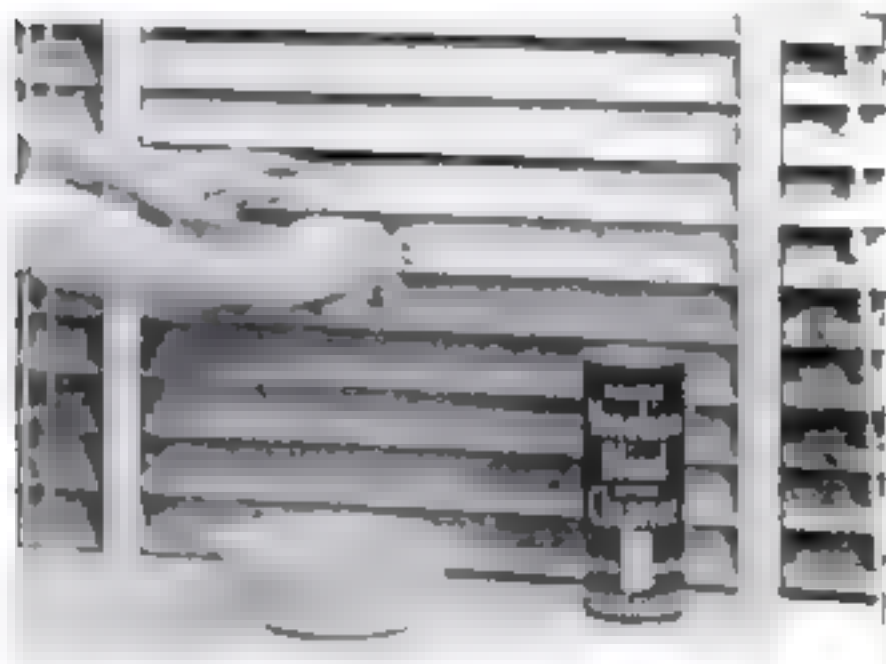




MARKET GOES TO HOUSEWIFE. This modern version of the old-time huckster who hawked his farm produce from door to door has been put in operation by Morton

Salter in Los Angeles residential streets. The traveling grocery store is a converted bus with all the fittings of a busy, modern market, and follows a regular route.

VENETIAN-BLIND CLEANING is speeded up by a new cleaning preparation made by Powers Products, of Chicago. The cleanser is a powder used dissolved in a quantity of water. One whisk with a cloth dampened in the solution, and a blind is clean. No rinsing is required.

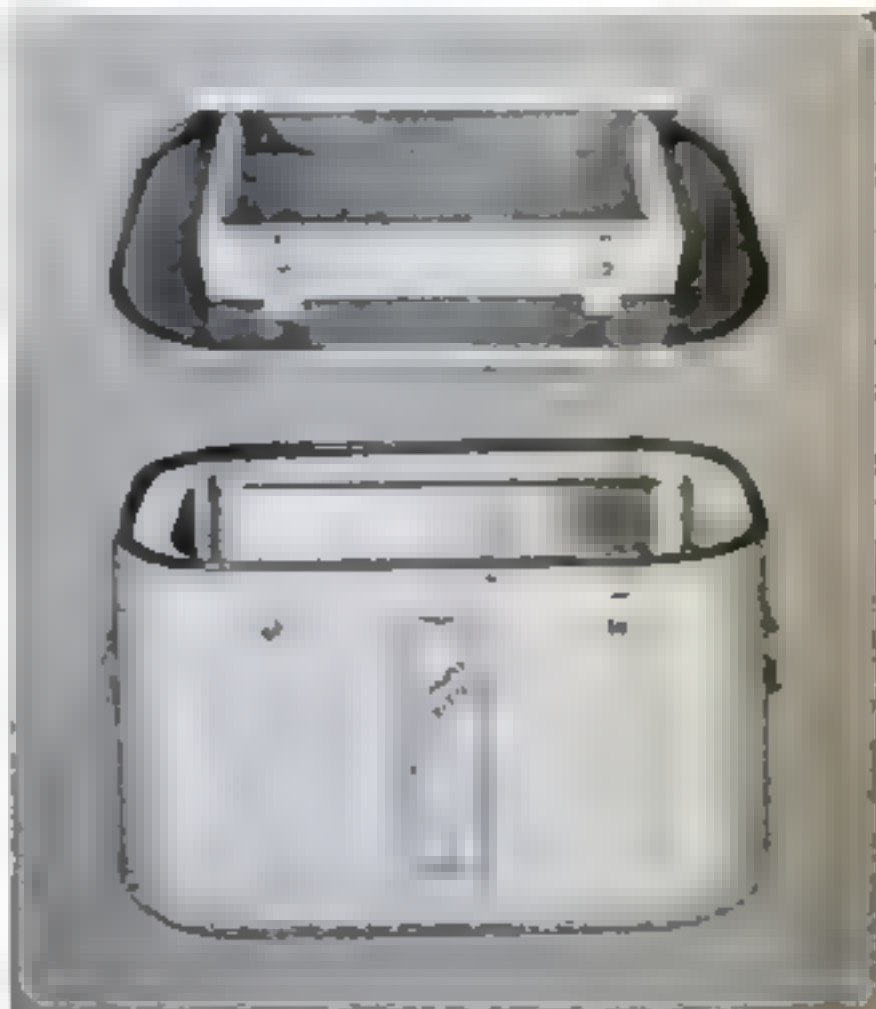


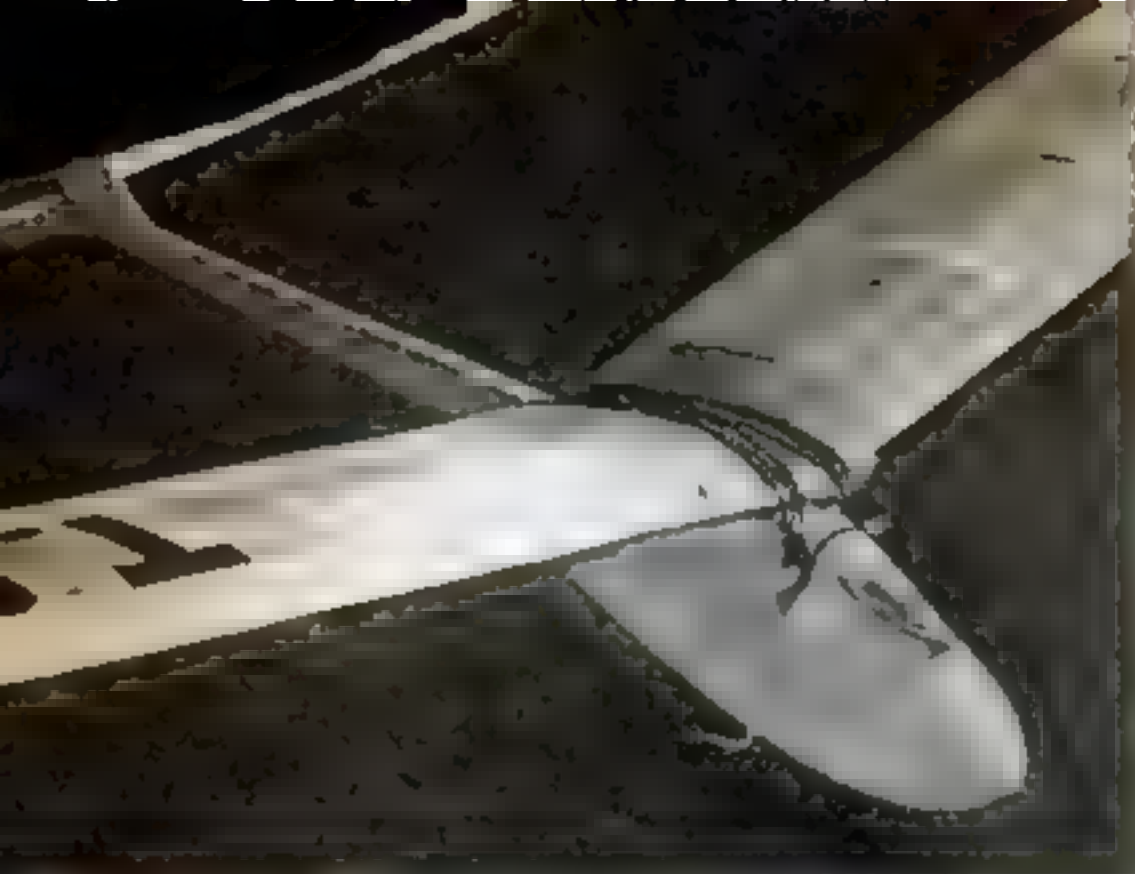
QUICK FREEZING in a portable dry-ice refrigerator makes practical the bringing home of fish and game from extended outings and the carrying of refrigerated food and beverages on long motor trips. This deep freezer, known as the Porta-Freeze, weighs 25 lb. empty and can be stored easily in a car trunk.

The unit has a plastic outer casing and an interior of aluminum separated by 2" of insulation. Sufficient dry ice for most requirements is stored in a compartment attached to the lid, and additional dry ice can be placed in the main compartment for extra-low temperatures. Regular ice takes care of normal refrigeration needs. The manufacturer is Calplasti Corp., of Los Angeles.



NYLON TUMBLERS that can be dropped on cement or tile without breaking are being manufactured by Du Bois Plastic Products, Inc., of Buffalo, from the Du Pont plastic. They are now made in 8-oz. size and natural nylon ivory, are light in weight, and are heat resistant for hot drinks or sterilization.





TOWLINE GLIDER

Polydihedral Wing and Proper Balance Produce Long Flights

EXCEPTIONALLY stable, this sleek little glider (shown in color on p. 120) has a very flat, moderately fast glide. If it encounters a thermal or two, flights may last an astonishing time. Its best so far has been 4 min., 20 sec.

After the plans have been drawn to full size, glue together the pod blank, the boom block, and the two sidefaces, aligning and locating the pieces as indicated. Use hard balsa for the boom, and medium for the pod and sidefaces.

When the glue has dried, trace the outline of the pod on the blank; then carve and sand the pod-boom assembly to shape, employing the templates shown in the drawings. Beginning $4\frac{1}{2}$ " from the front, taper the boom to $\frac{1}{2}$ " by $\frac{1}{2}$ " at the tail. Mortise the wing mount into the boom flush with the V-notch in which the polydihedral wing

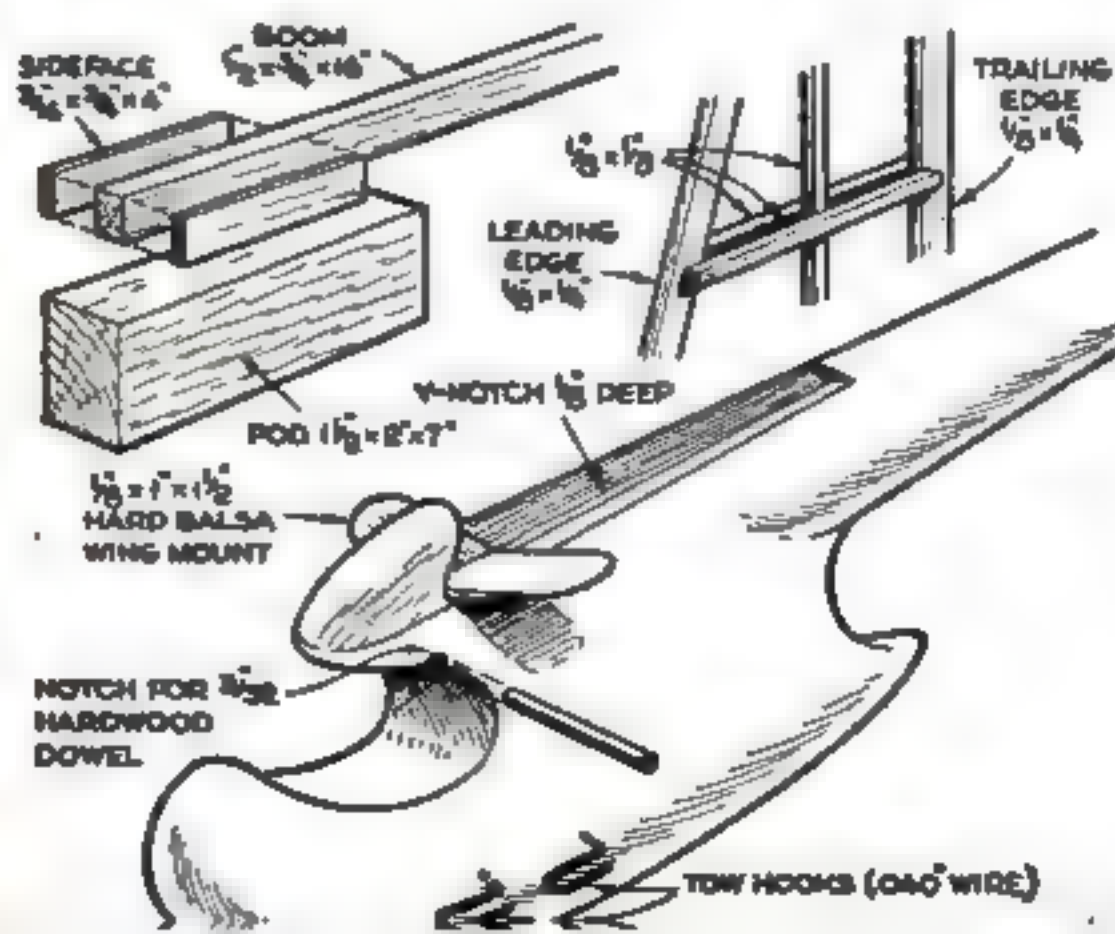
rests. Shape the fairing block in front of the wing after the wing is in place.

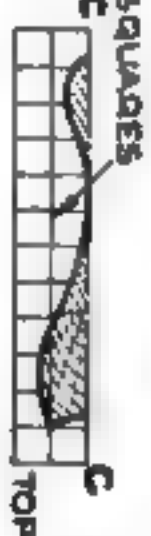
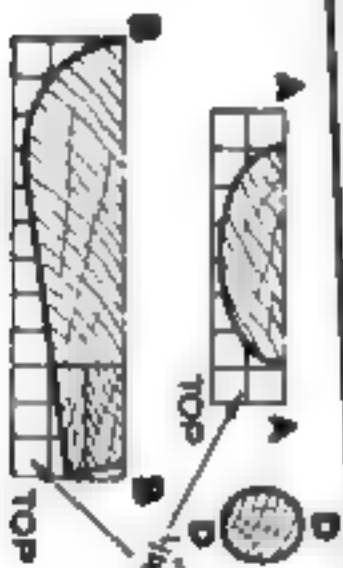
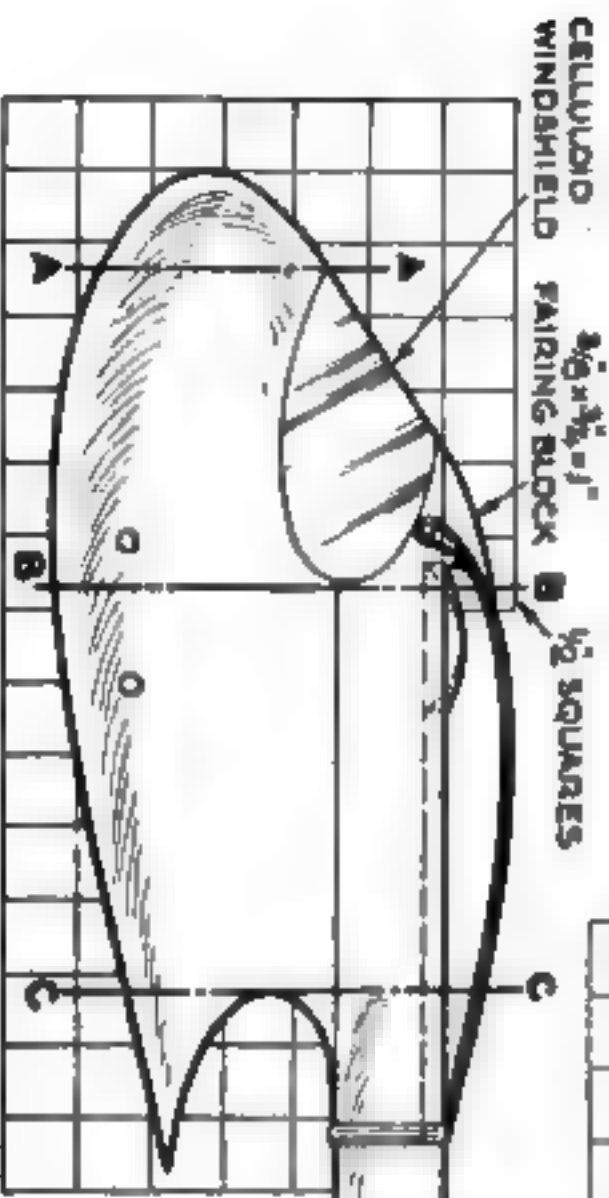
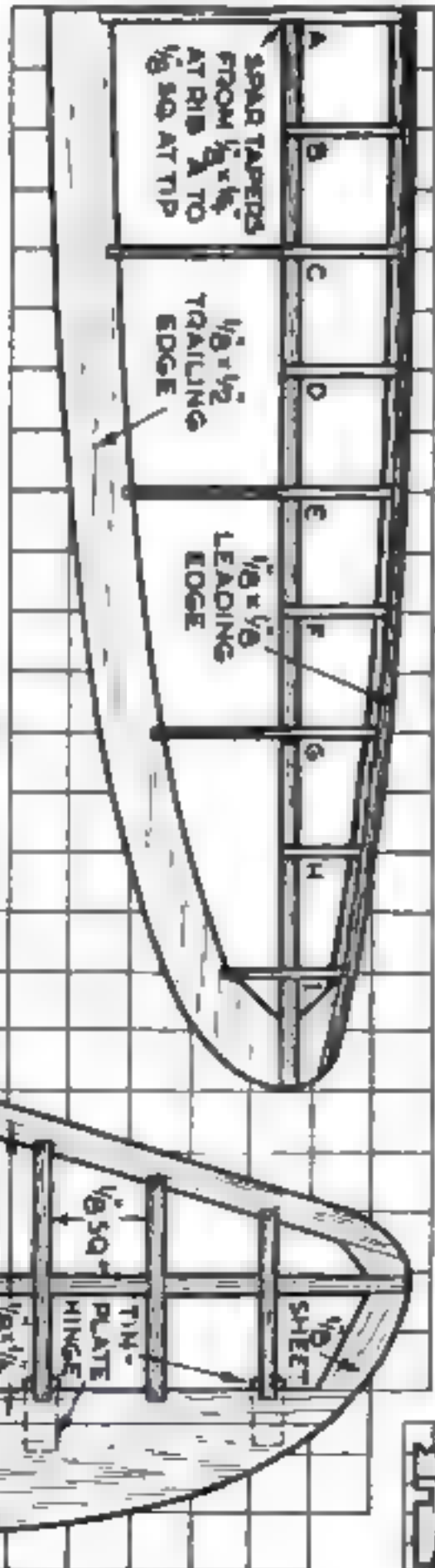
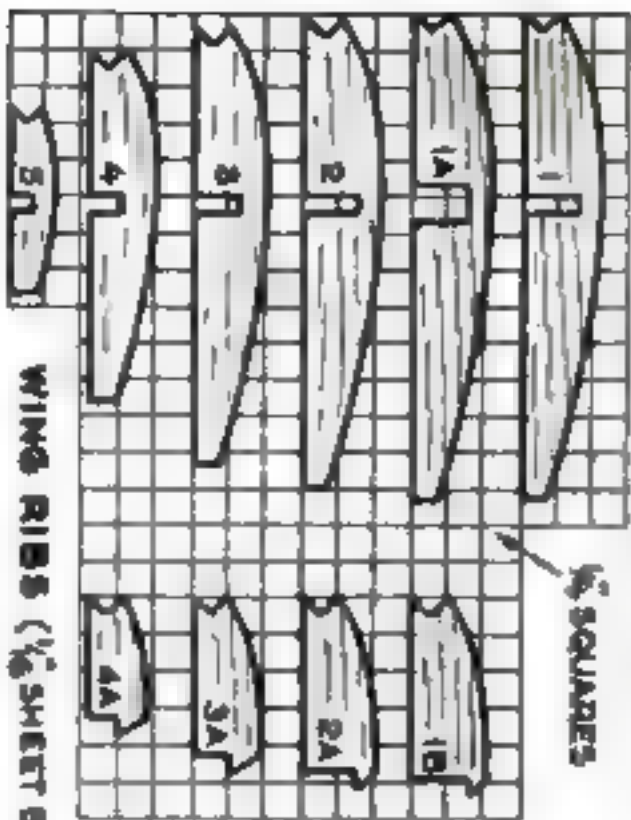
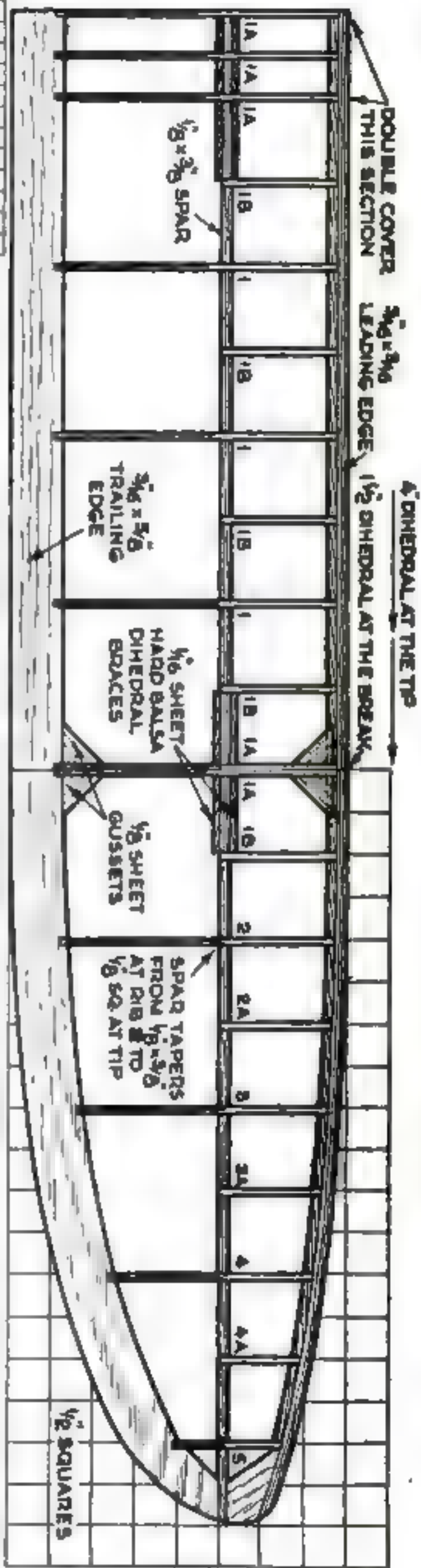
The wing is built as one piece with a dihedral of $1\frac{1}{2}$ " at the twin ribs $1A$ and 4 " at the tip. The trailing edge is built up of four pieces, but 36" lengths are used for both the leading edge and spar. Set the ribs in notches $3/32$ " deep in the trailing edges of both the wing and elevator. Build the rudder frame with twin horizontal braces as shown below and, with sandpaper, fair these into the leading and trailing edges. Shape both the fin and skid from $\frac{1}{2}$ " balsa and hinge the fin with tin cemented into slits in both edges. Cover wing and tail surfaces with clear dope. Later apply pigmented dope to the entire glider.

In the first test flights, add clay to the nose until a flat glide is obtained. Then adjust the fin for a circle.—JAY T. HOLMES.



Attached with tin-plate hinges, the fin is adjustable for circular flight. Twin horizontal $\frac{1}{2}$ " by $\frac{1}{2}$ " members in the rudder are faired at both ends. Two hooks give a choice of towing angles.





SPAN 36
LENGTH 17 1/8
WING AREA 132 SQ IN

HOOKING UP

CONFRONTED with a big lawn and the ordinary muscle-power mower, practically anyone is apt to begin dreaming up ways of making the job a little easier. Judging from the results displayed on these pages, there must have been plenty of this kind of dreaming in the United States in the past few years.

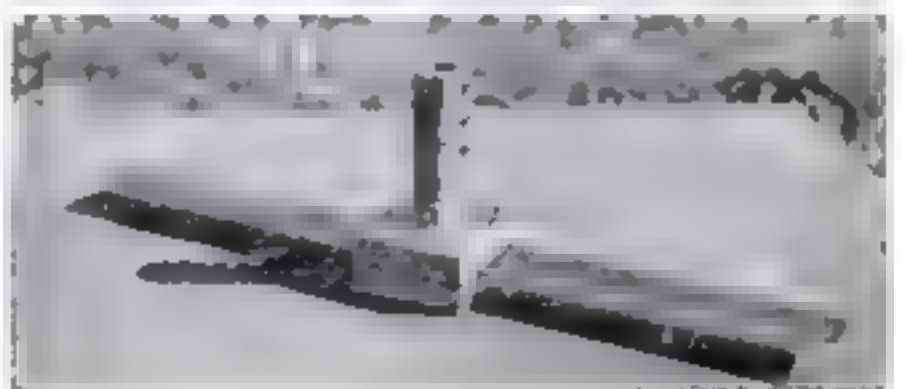
After publication of an article describing a power lawn mower that employed used razor blades (P.S.M., May '45, p. 197), a number of readers reported that they, too, had built their own power mowers or hooked up a means of power to existing machines. Here are a few of the best.

Because few lawn mowers could be purchased during the war years, some home owners started from scratch, using whatever materials could be had. Three such entirely home-built mowers are illustrated. In each case, the builder employed blades whirling parallel to the ground at high speed, instead of the spiral knives of the traditional mower. Although developed independently, two of them (the one at the left and the one at the bottom of the following page) bear a remarkable resemblance. The first, however, is run by a gasoline engine while

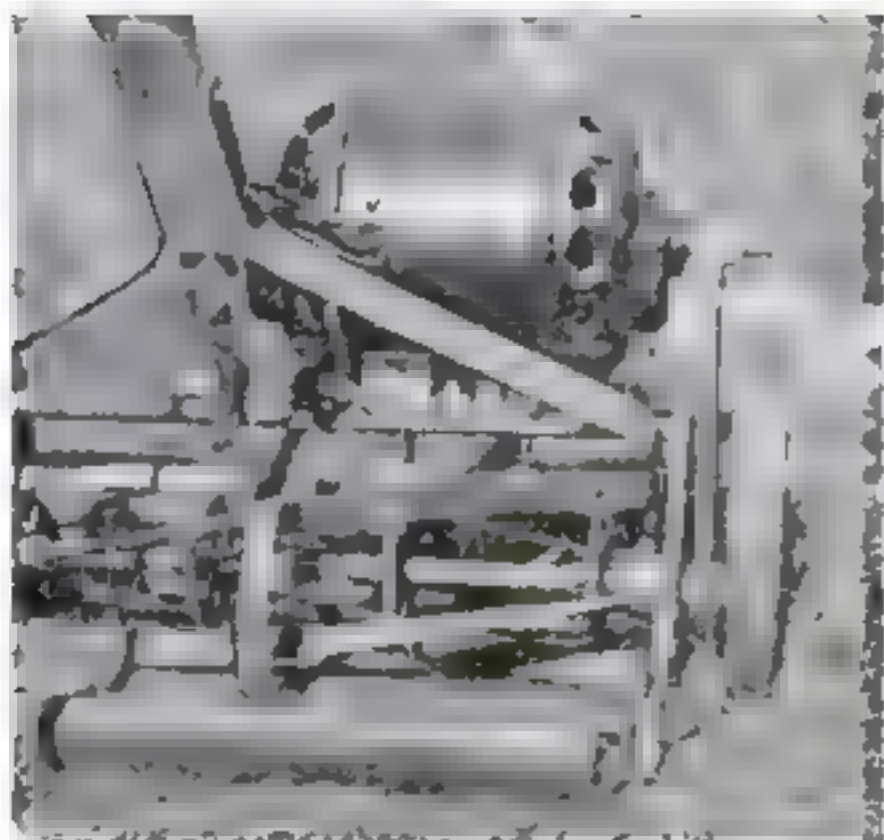
Powered by a 1½-hp. gas engine, the 26" blade of Hugh James's machine spins at nearly 2,000 r.p.m. Suitable for weeds as well as a lawn, it won an Illinois contest for labor-saving gadgets.

Many homemade lawn mowers trail an electric cord like a vacuum sweeper. Carl W. Thompson, Jr., of New Castle, Del., built this wood-frame machine.

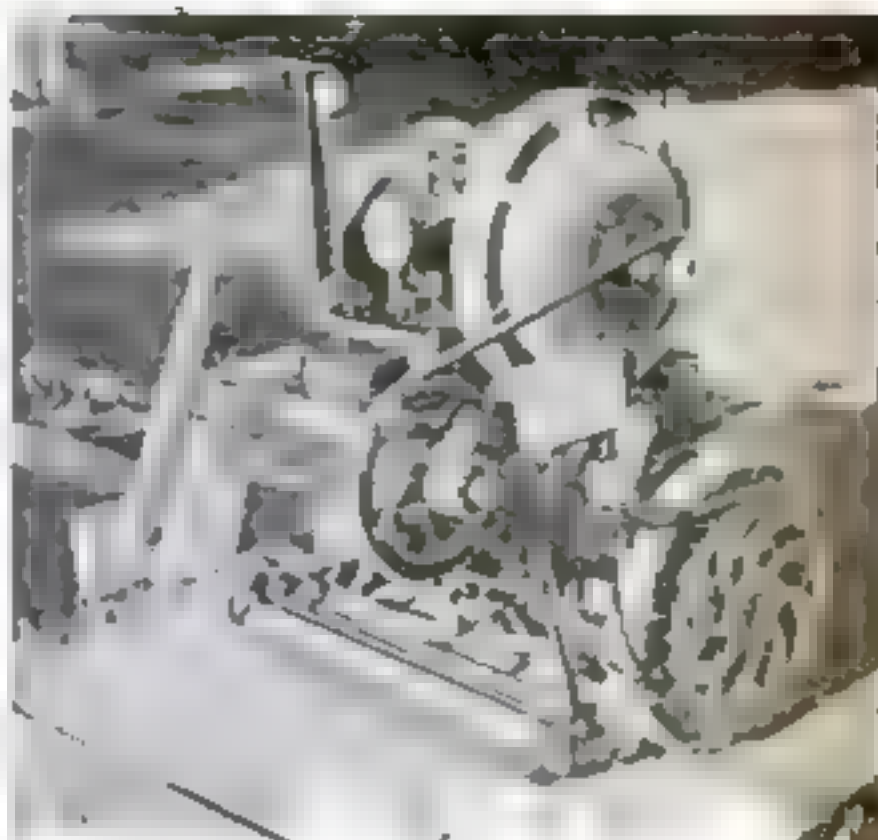
These two types of cutting blades have been used on the mower at the left. The builder says that the sheet-iron disk gives a good flywheel effect.



POWER to the HOME LAWN MOWER



V. E. Todd removed the pawls, allowing the wheels to run free, and belted power to the cutter only.



Bicycle sprockets and a gas engine were used by J. Greene MacKenzie for his power-propelled job.

the other is limited in its field of operation by a heavy electric cord reaching to an outlet in the house or garage

Most of these examples of lawn-mower ingenuity use power only to drive the cutting blade, and the job of pushing the machine over the lawn remains. Only one—that at the upper right on this page, is fully powered. It does the work and you just tag along behind.

John Macfie, of Garden City, Mich., reports that he mows "everything in sight" with this cutter. The 14" blade is spring steel, sharpened with a file, and carefully balanced to prevent it from vibrating.



Laying out and assembling walls

SECOND OF A SERIES

Last month Mr. Love gave instructions for laying a slab floor. Succeeding articles complete the building of a small house.

By **EDWIN M. LOVE**

ERECTION of the frame sides of a small building, such as a garage, workshop, or small house, can begin as soon as the concrete-slab floor has well set. Strip the forms from around the floor by driving back the stakes, pulling the nails, and prying up the ends of the forms.

Damage to the floor can be prevented by pulling the pieces upward and outward.

Nailing on upper trimming header to a stud. Frames are made flat on the floor with the bottom of the studs against the mudsill. Arrows, or "truth" marks, on the plate indicate studs framing headers.



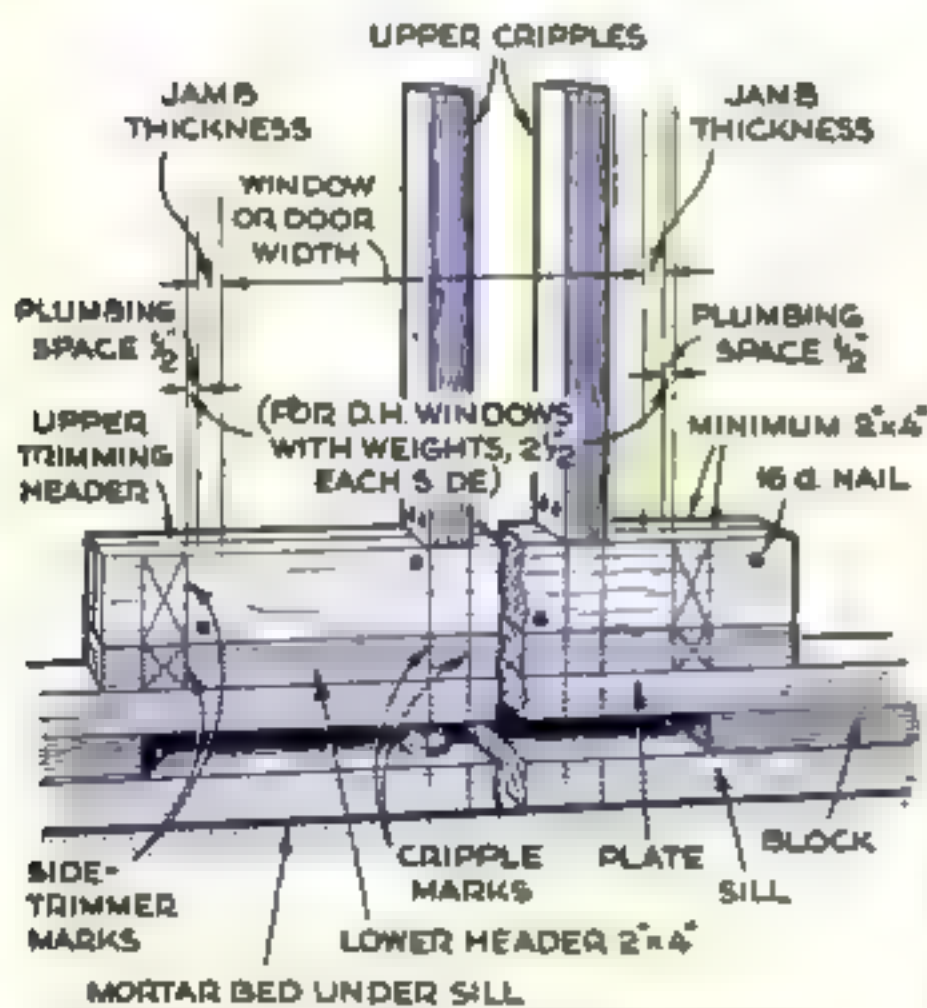
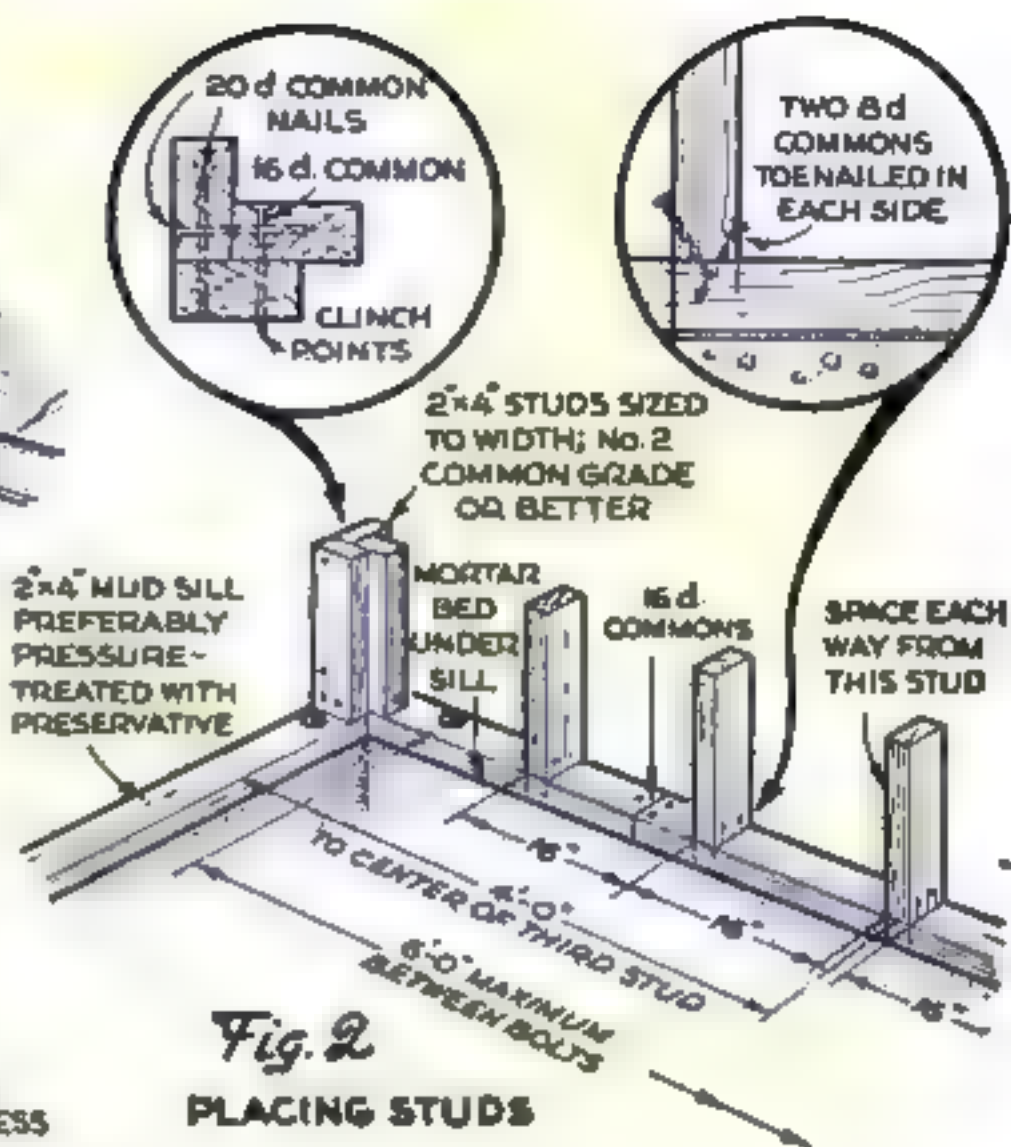
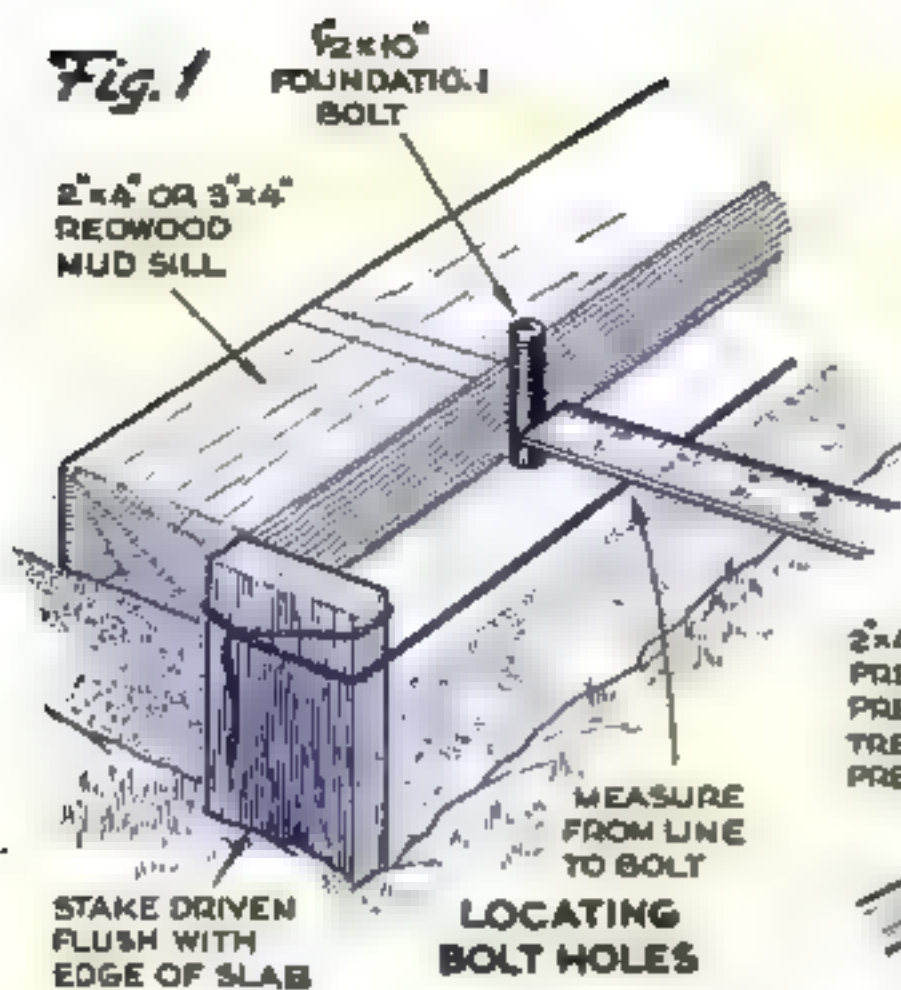
The wood can be salvaged for use in the building if it is scraped clean and piled neatly. To avoid the possibility of accident, remove the nails from all scraps and lumber regardless of re-use.

Materials for the mudsills will vary according to the locality. Whether white pine, fir, hemlock, redwood, or other stock is commonly used in your section can be learned by asking a few questions around town. Often the wood is obtained impregnated to resist termites. Building laws should be consulted for any regulation covering sills. If 3" by 4" stock is not specified, two-by-fours will do.

The mudsills form the lower plates for walls and partitions. Lay them on the floor

in an order that allows them to be cut to advantage, and mark and bore them to receive the foundation bolts, as in Fig. 1. Wet the concrete floor and trowel on it a thin layer of cement mortar in which to bed the sills. Make up the mortar of 2 parts fine sand mixed with 1 part Portland cement. Add water to one small batch at a time—just enough to provide mortar for one length of sill. Check each sill for straightness and level with a straightedge as the work progresses, tightening the bolt nuts only enough to hold firmly. When all sills are in place, check also for straightness and squareness on the floor, and finally tighten down the nuts.

Build frames flat on the slab floor, as at left. Plates should be sized to uniform thickness and length. If studding or other lumber unsized for thickness is used, an uneven ceiling line will result. The plates are laid on the sills to



WINDOW STACKED FOR MARKING

Fig. 3

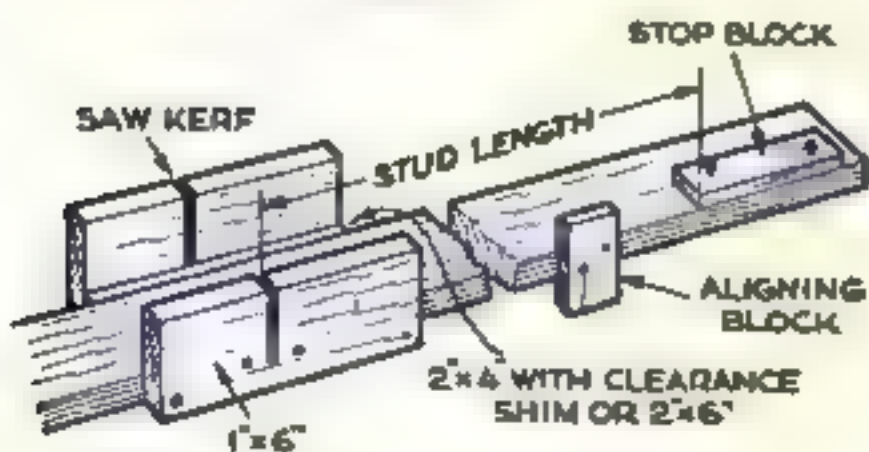


Fig. 5 MITER BOX

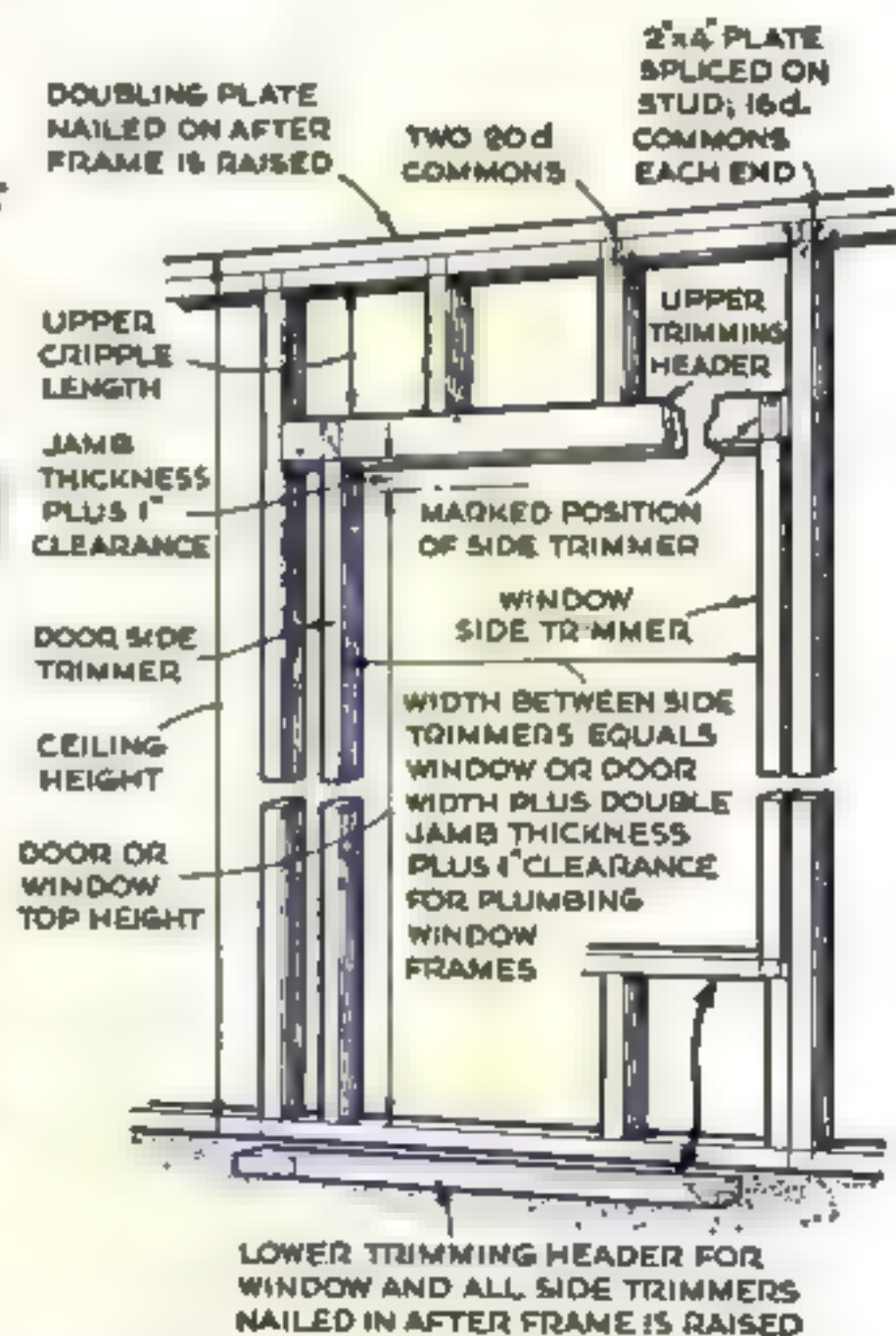
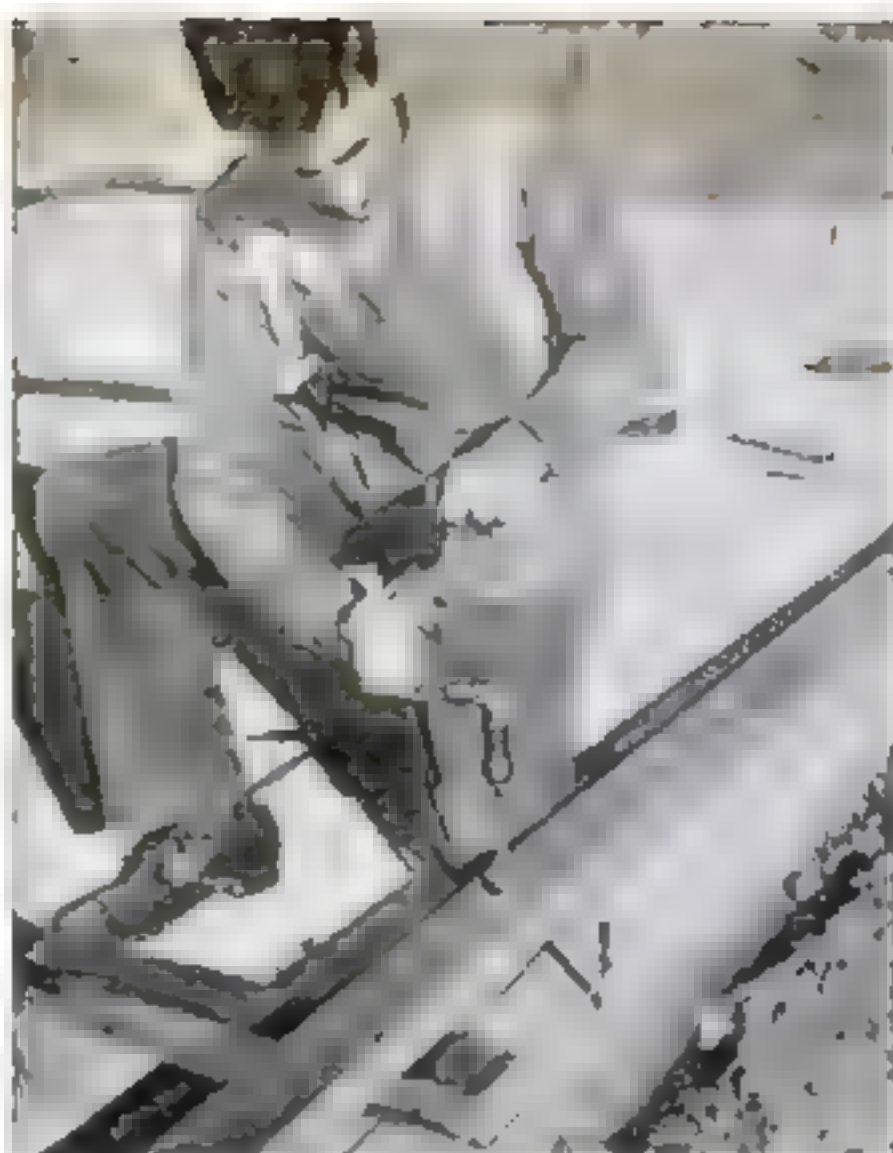


Fig. 4 OPENING DETAIL



Squaring a line on the sill for bolt holes. The distance from the edge is taken from a guide string.



Boring the sill for bolts. Note that the sill is blocked up to protect the bit as it goes through the wood.

facilitate marking both the plates and sills for studs at the same time. Block up the plates, as in the photo on the facing page, to clear the ends of the bolts. Then align the end of the first plate with the starting corner and tack in place.

Studs are usually spaced for convenience in lathing or installing such lining materials as plasterboard. Starting from an inside corner, measure 48" to locate the center of a stud (Fig. 2), which places it where a lath or sheet will fit without cutting and also leaves half the thickness on which to nail the next piece.

Mark both sides of this stud and space from it in both directions, using the tongue of the framing square as a distance gauge. When the end of a plate is approached, cut it off square for splicing on the center of a stud. Butt the next plate against it, tack it, and proceed as before. Place a stud in a corner at a partition and start anew, laying out from the inside corner of the next room. Lay out the opposite wall in the same direction. Partitions are laid out in the same manner.

When laying out door and window openings, make allowance for the net width, the thickness of the jambs, and an extra 1" to allow for plumbing in case side trimmers

are nailed in out of plumb. Double-hung windows installed with sash weights instead of spring balances require additional width for weight pockets.

Locate the openings by measuring to the centers and place the trimmers accordingly. The trimming headers must abut regular studs on both sides of the openings, and excessive spans can sometimes be reduced by shifting a door or window a few inches to one side. Indicate plainly on the top of the plate with arrows (called "truth" or "witness" marks) which studs the trimming headers go between.

The dimensions of headers must conform to local building laws. Two two-by-fours spiked together and placed on edge are usually satisfactory for openings 4' or less in width. Cut a single two-by-four lower trimming header for each window. Stack the three headers in place on the plate, as in Fig. 3, and mark on their inner edges the positions of the side trimmers and the short studs known to carpenters as "cripples." How the pieces are marked is shown in Fig. 4.

If a few studs are to be cut, use the pattern method. Lay several two-by-fours on saw horses and square the ends; then cut one to length, tack a block against one



Marking studs on a plate shimmed to clear bolts. The 16" tongue of the square gauges stud spacing.



Cutting studs to length in a miter box. A stop block near the end sets the length automatically.

end, and use it as a stop against the cut ends for marking the lengths.

The miter-box method is better for cutting a considerable number of studs. Nail a piece of 1" by 6" stock to each edge of a 2" by 6" (or a two-by-four widened with an edge shim for clearance) and make a square cut through the sidepieces, as in Fig. 5. Measure the length of the stud on the side at your left, nail down a stop block, and add an aligning block on the edge.

If the ends of the stock are not square, locate the miter box near the center on an 18' piece, nail an aligning block near the right end, and then lay in a piece for a stud, square its end, and slide it to the left for cutting length. Fewer cuts are required when studs are sawed from 16' lengths rather than 8' pieces.

The same miter box, with the stop block relocated, is used for cutting cripples, the lengths of which depend on various factors. Nail them to the upper headers with four 4-d. nails in each cripple.

To nail studs, lay the plates near the center of the floor with their marked edges up and place the upper headers. Be careful not to turn them end for end, a mistake that causes confusion. Lay studs between the sill and plates, choosing the straightest

to frame the openings. Take up 20-d. nails with the points toward the wrist and start them with single blows, two nails to a stud, in one length of plate.

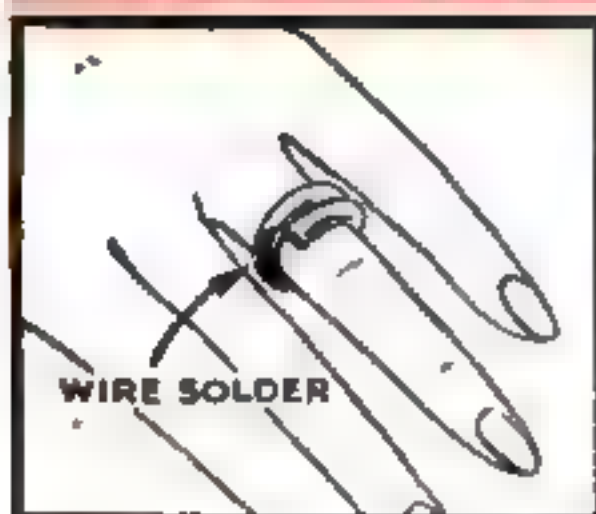
Lay each plate full length on the floor, if possible. If one end must lie on a sill, prop the other to correspond. The fingers can then be slipped under the edge to even it with a stud while nailing.

There are several good ways to build corner posts. That shown in Fig. 2 is a "California corner" and consists of three studs with a solid inside corner and an outside corner stud. Nail with 20-d. and 16-d. commons, as shown, spacing the nails 16" to 18" apart, and nail the corner to the plate to raise with the studs.

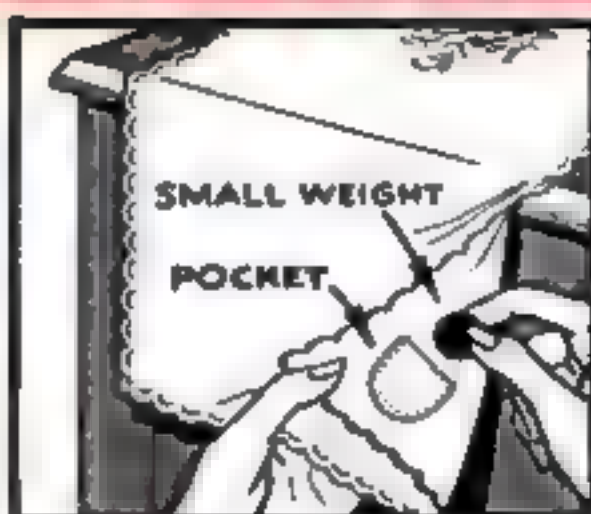
When trimming headers have two or more cripples, they can be nailed to the plate and then to the framing studs without measuring down from the plate. But if carelessly assembled, a header may be out of level when the wall is raised.

Obviously walls must be raised as nailed and in such an order that the plates will slip into place between plates already raised. If a plate is to project beyond one on a standing wall frame, that frame will have to be racked out of plumb temporarily to let it pass.

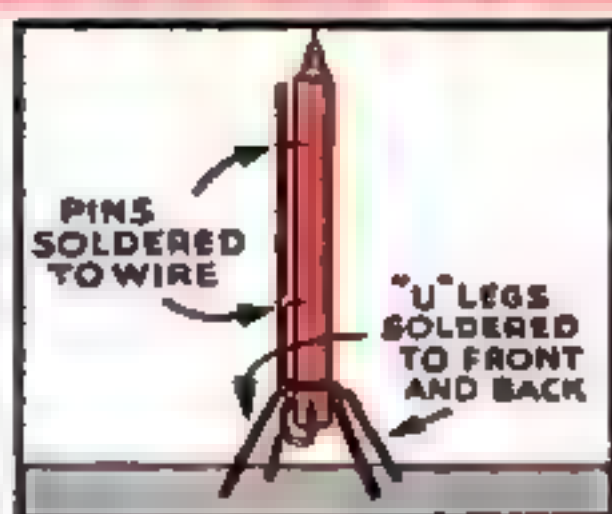
KEEPING THE TRIVIAL



Wire solder wrapped around the finger and adjusted as required will give your ring size. Such a guide is particularly helpful if another person picks the ring.

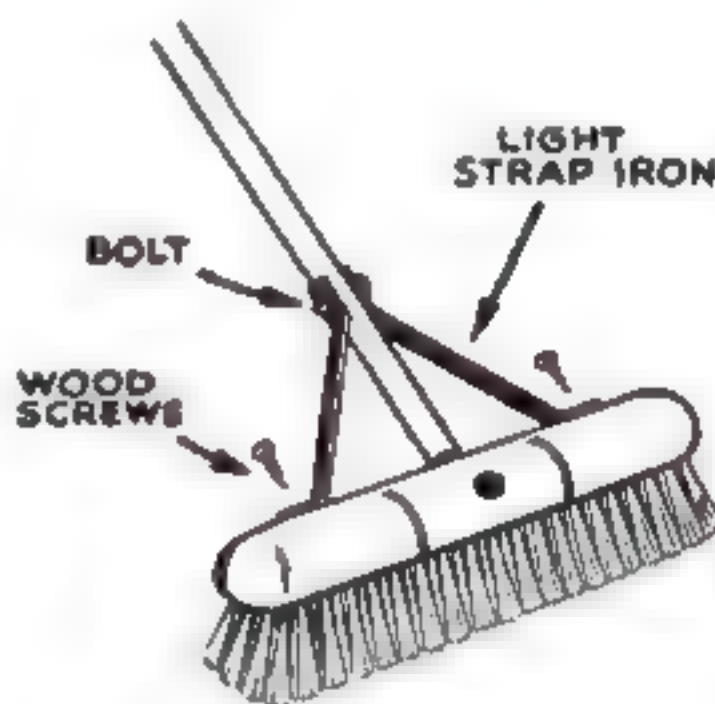


Weights placed in pockets at the corners of a scarf or runner on top of furniture near a window or door will keep the ends from blowing up and becoming untidy.



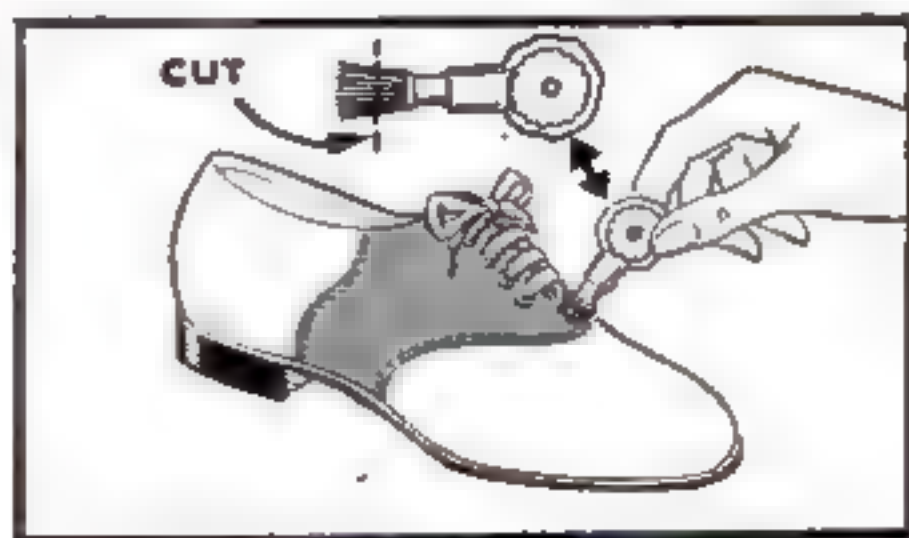
Candles in ordinary holders have a tendency to sag in hot weather. Made from $\frac{1}{8}$ " welding rod, the holder above prevents this. Pins in the upright support the candle.

Earrings often have an annoying habit of becoming separated and jumbled together with the rest of the items in a jewel box. A narrow strip of wood placed across the end of the box provides a convenient spot to hang each pair so that they will remain together.

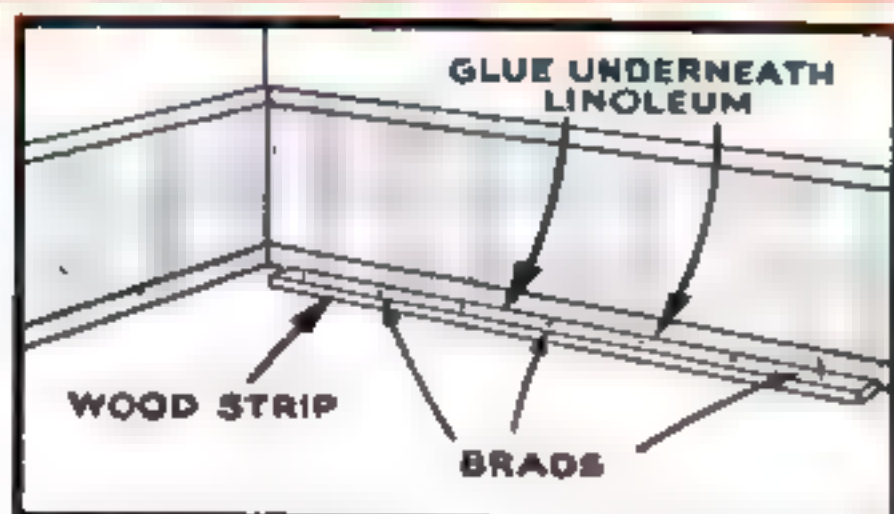


Braces of light strap iron on a push broom lessen the chance that the handle will break off at the juncture. They also will make the broom more rigid. Drill and bend the braces as required and fasten them with a bolt and screws as indicated.

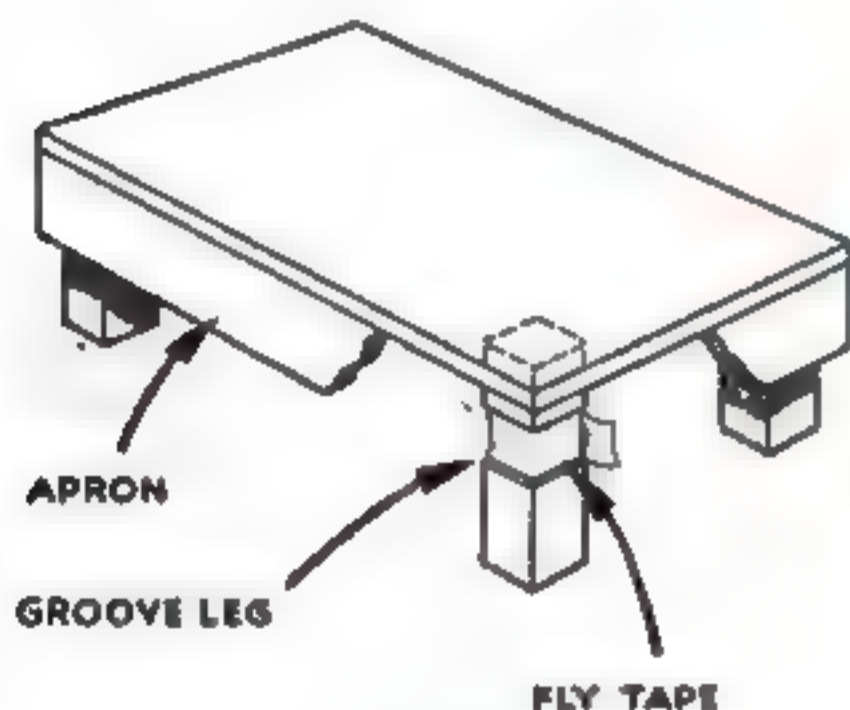
An old typewriter-eraser brush, trimmed down with scissors until it is much stiffer, makes a good shoe-polish applicator. The brush is especially useful for spreading polish of different colors, without smearing, on summertime two-tone shoes.



SHIPSHAPE



When linoleum curls up at the edge, apply glue to the underside, and then tack it down with a wood strip, spacing the brads about 6" apart. When the glue has dried, pull up the stick and remove the brads with pliers. The holes will not be noticed.

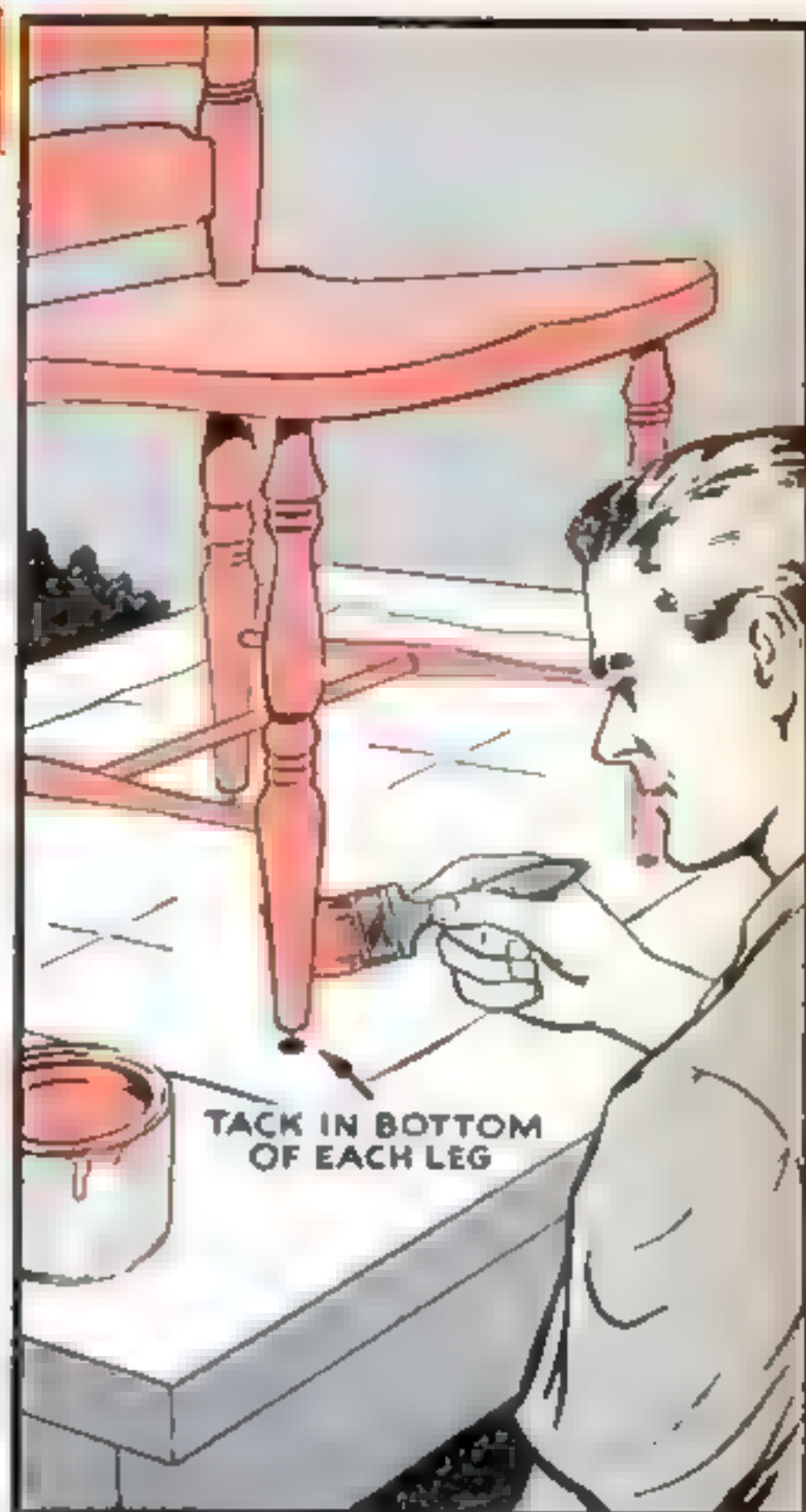


Crawling insects such as ants sometimes come to a garbage can looking for a handout. They will be forced to look elsewhere, however, if you place your can on the stand above, for the fly tape will stop them. Its stickiness will last a long time.

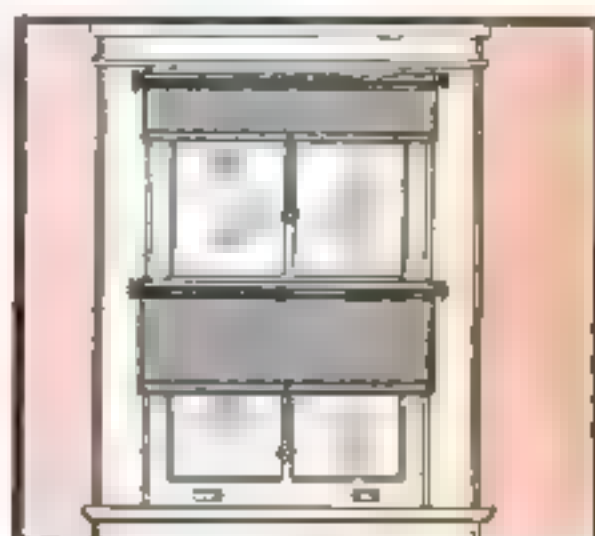
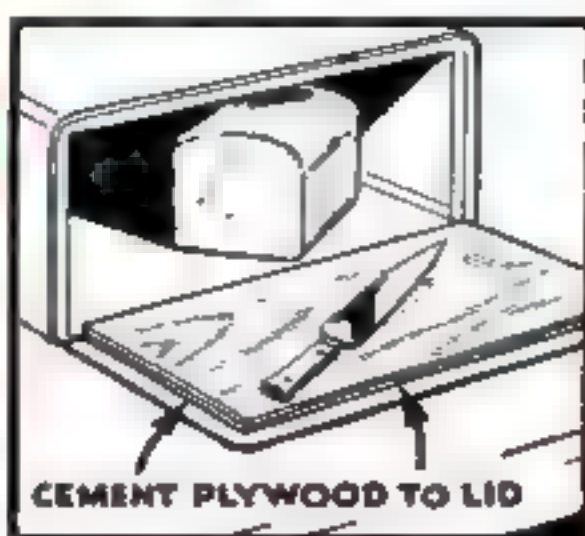
A mailing tube with a screw cap provides a convenient means of storing checkers so they won't become lost. If you wish, the tube can be painted and labeled.

Plywood cemented to the inside of a bread-box lid will serve as a handy cutting board. You also may find it convenient to store the knife inside the box.

Attached midway between the top and bottom of a window, a second shade affords privacy when drawn and at the same time allows light to enter through the top panes.



When painting a chair, table, or similar piece of furniture, you can do a more satisfactory job by driving a large tack part way into the bottom of each leg. You then can paint to the bottom of each leg. If the paint runs a bit, it won't do any harm.



CRAFTSMEN AT WORK



CARVING WOODEN HORSES from scraps of 2" yellow pine is the spare-time hobby of Donald R. Nelson, of Hastings, Neb. The horses are about 10" long, and all are fitted with ornamental trappings. Riders are in the Western tradition, some with guns and guitars on slings. For trimmings, Nelson uses pieces of aluminum, kid gloves, horsehair, thread, wire, and pins. His tools for the most part are a jackknife, pliers, and a file.



THIS MODEL TELESCOPE was made from bits of wood and scraps of brass to conform to the design of a large reflecting telescope. It has a 6" long tube assembly but no lenses, mirror cell, cap, setting circles, and a finder telescope. The model will revolve on both its polar and declination axes. Brass fittings that include $\frac{3}{8}$ " of $\frac{3}{32}$ " brass rod representing the finder help to give it an authentic look. Frank W. Dresser, of Philadelphia, was the modelmaker.



BOARDS ARE SAWED from logs 6" in diameter in a working model of a full-size sawmill built by the Philadelphia office of the U. S. Forest Service for demonstration purposes. Metal dogs no larger than a little finger grip the wood firmly as slabs and boards are sawed. They are exact models of huge arms used on the West Coast for holding and turning giant logs. The little sawmill is operated by a 1-hp. electric motor and saws accurately to any desired size for showing young foresters certain phases of "sawing for grade."



PLASTIC FOR A WAGON is unusual, but Donald R. Doremus, of East Rutherford, N. J., used it almost exclusively for this one that seats two children. Running gear and tongue are of clear plastic, and the body of gray plastic.

THREE-WAY KNIFE

for the Fisherman



By WILL THOMAS

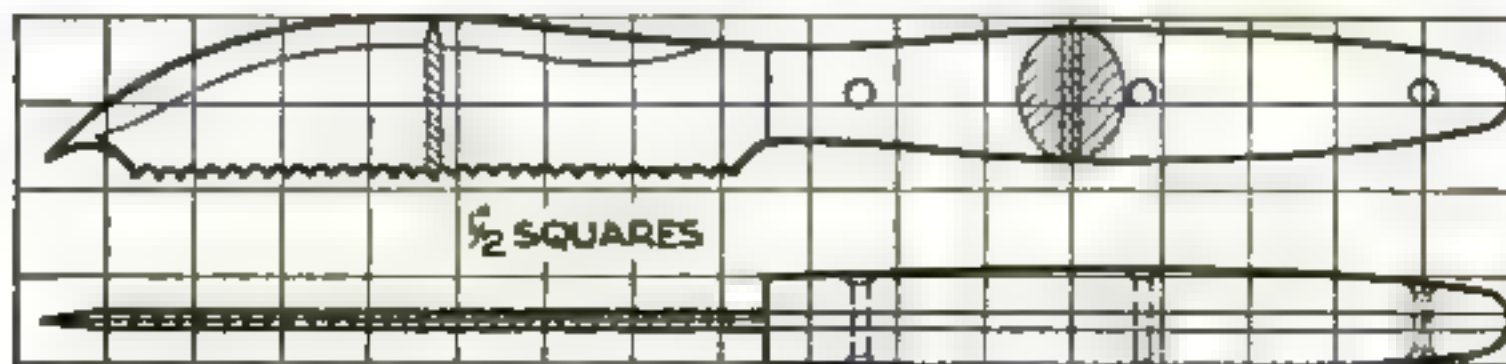
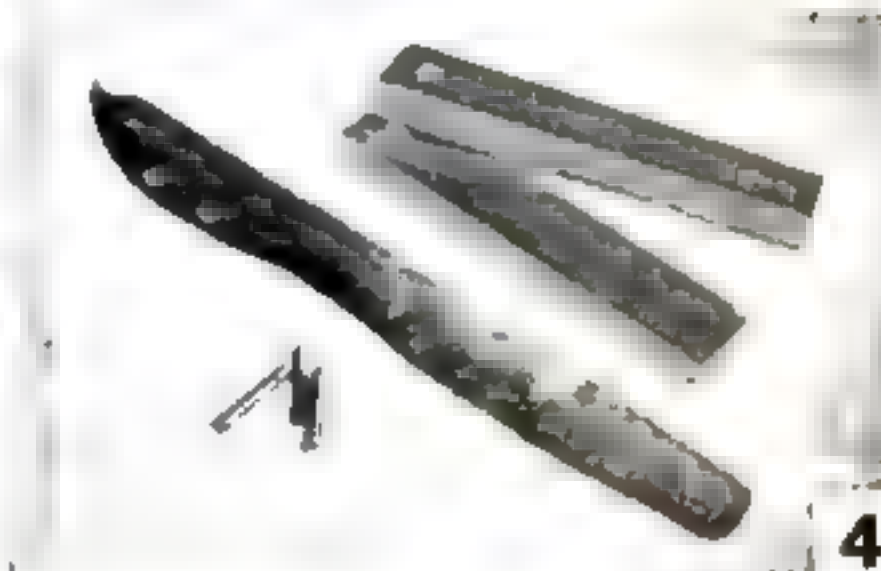
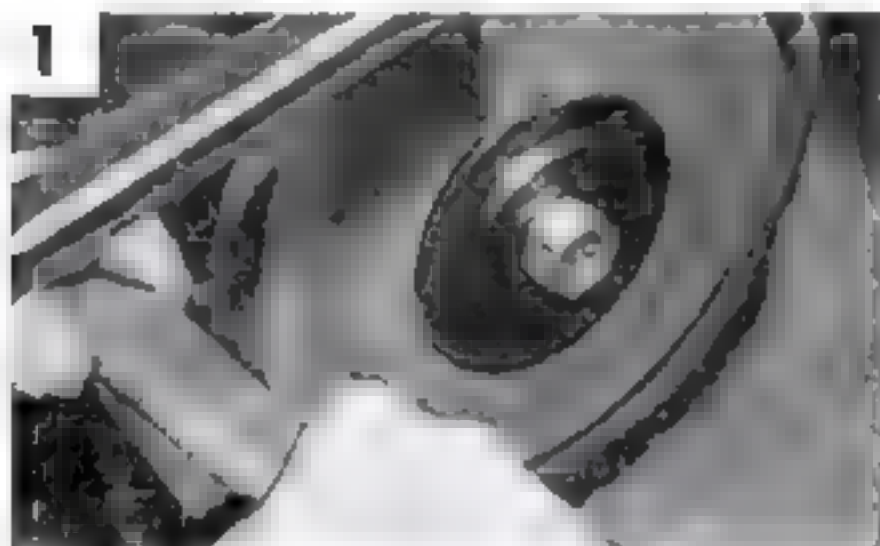
SAW teeth on one edge of this knife blade remove fish scales quickly, the cutting edge is keen and curved, and the hooked end is excellent for slitting skin and taking out fishhooks. The knife itself is made from a length of used power-hacksaw blade, and the handle from two pieces of plastic or hardwood.

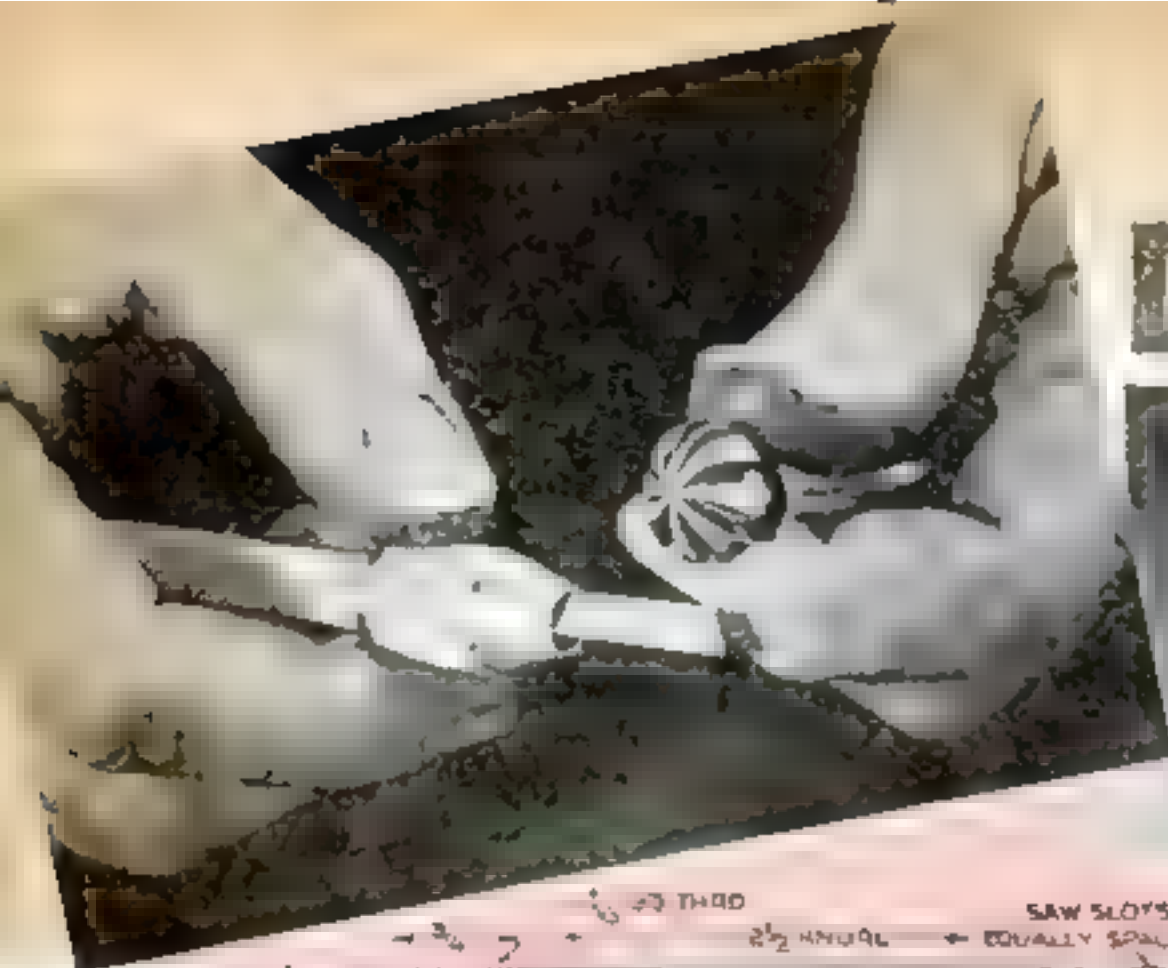
Select a blade that is hardened throughout, if possible, and grind on a coarse wheel (Fig. 1) to the shape shown in the drawing. Then grind the side rake off the teeth, as in Fig. 2, and shape the edge roughly. Next,

grind the hook on the point. This can be done with a wheel mounted in the drill press, as shown in Fig. 3, or with a small hand grinder. Dip the blade in water frequently to prevent overheating during grinding.

Wrap the blade part and heat the tang red and let it cool in air to anneal for drilling. If a soft-back blade is used, this will not be necessary, but the cutting edge of the blade will have to be hardened after the drilling.

Assemble the handle and blade (Fig. 4), drill, countersink, and rivet. Shape the handle on sanding disks and polish on a buffing wheel. Then sharpen the cutting edge.





NEW SHOP IDEAS



OILSTONE CHUCK. Holding a small triangular oilstone, this chuck makes it easy to use such a stone without cramping the fingers. It also saves waste by permitting the use of short ends of stones that ordinarily would be thrown away.

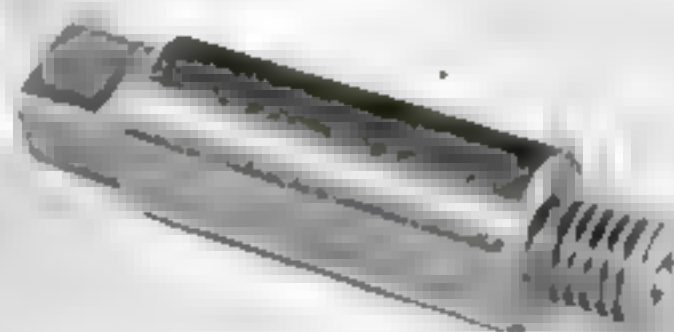
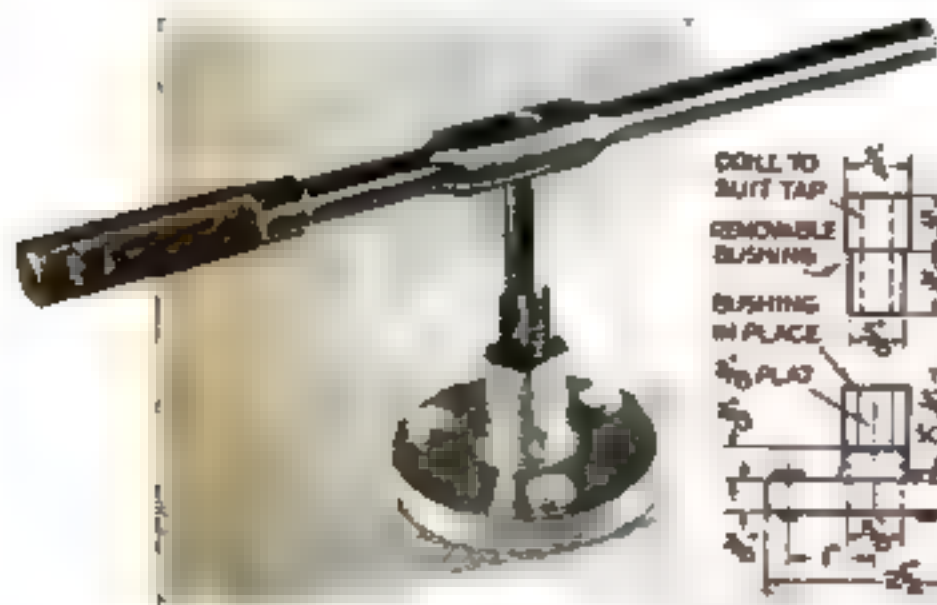
The handle is $7/16$ " aluminum rod, machined to shape, knurled, and threaded, as shown. It is next drilled all the way through with a $5/16$ " drill so the sharpening stone

will slide through easily. Three evenly spaced $1/16$ " slots are then cut carefully in the threaded end with a small hacksaw to provide clamping action in the chuck.

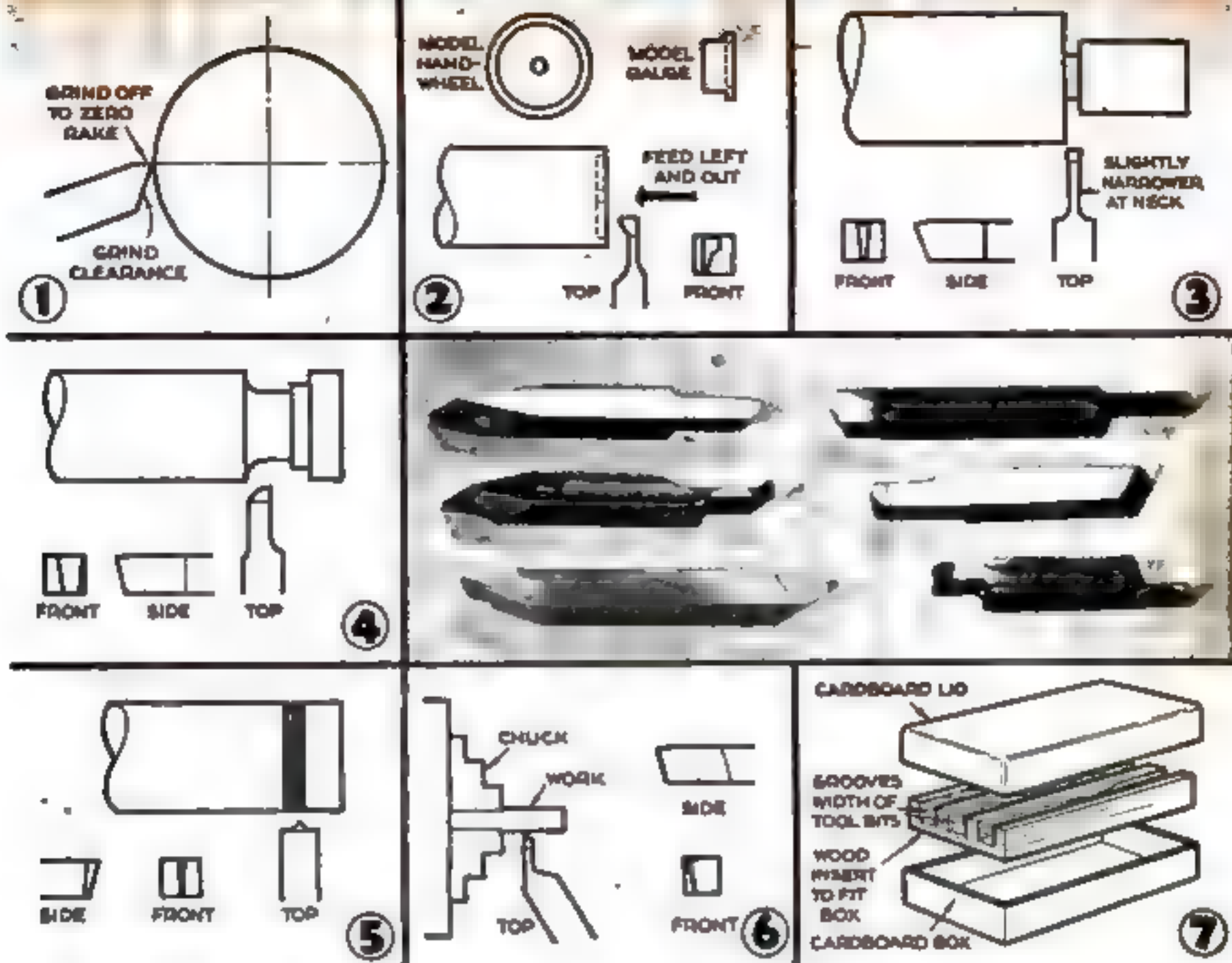
Turn the closer from aluminum and knurl it. Drill through with a $5/16$ " drill, counter-bore the portion to be tapped with a $25/64$ " drill having a 60-deg. point, and open up the back with a $7/16$ " drill. Tap the closer $7/16$ "-20.—FRANK McCARTY.

TAPS START SQUARE with the surface of the work when pushed through a guide like the one shown below. The base of the device is made up from a steel disk bored to receive bushings. These are drilled an easy fit for various taps without undue play. Three cap screws in the base act as feet for accurate setting above chips, burrs, and irregular surfaces.

The guide is clamped down or held by hand for the first few threads and then removed. Flats on the bushings assist removal in case of binding.—C. W. WOODSON.



NUT MANDREL. One problem that sometimes arises when nuts are made up from bar stock is that the threads may not be accurately true with the face. While such inaccuracy is frequently unimportant, it is not desirable in applications where the nut is highly stressed, or where appearance is a factor. A simple nut mandrel, shown in the photo above, permits taking a light facing cut to true up the nut. Such mandrels are made of 4" lengths of $3/8$ " machine steel, centerdrilled, flattened on one end for the lathe dog, and threaded for a length of $3/4$ ". Each should be stamped with the size of thread it bears.—C. W. W.



TURNING BRASS. A favorite of model-makers, instrument makers, and other fine craftsmen, brass requires lathe tools ground, as in Fig. 1, to have no rake, or even a slight negative rake. The special modelmaker's tools shown above, which will do several tricky jobs not easy with regular tools, should all be ground to zero top rake, and like other brass-turning tools should be set at exact center height.

Figure 2 shows a cutter for forming hand-wheels, gauges, and other work with a recessed face. Time is saved by shaping both ends of several pieces of stock with this,

and then changing to the cutting-off tool. A cutting-off tool that can also be used for plain turning is shown in Fig. 3. The trick in cutting off is to start a chip and stay with it until the cut is completed.

A fillet to the left and a shoulder at the opposite side can be obtained with a cutter like that in Fig. 4. Reversing the design will make a right-hand tool. Fine grooves to represent a joint, gasket connection, ribs, or flanges can be turned with the tool in Fig. 5. The cutter in Fig. 6 works close to the chuck without danger. A box for cutters is shown in Fig. 7.—HERBERT PFISTER.



DRILL-PRESS SAFETY prohibits holding the work by hand, since injury to the fingers is a real possibility if the drill grabs. Designed for small flat parts that don't fit handily in a drill-press vise, the clamp at the left is made from two pieces of cold-rolled flat stock. Two hollow-head screws at the end are adjusted to fit the work, and then the thumb-screw, which threads into the small top plate but simply bears against the long lower one, is turned to clamp or release it.



Cylinder, Piston, and Connecting Rod

FOR YOUR HIGH-SPEED GAS ENGINE

PART II

By J. C. MAGEE

DESIGNED for assembly without gaskets, this little engine has few intrinsically critical dimensions, though it does call for painstaking work to produce gastight fits between mating parts. But if the cylinder is bored a thousandth or so oversize, it is only necessary to make corrections in the piston and ring so clearance and fit are not changed (see P.S.M., June '46, p. 146).

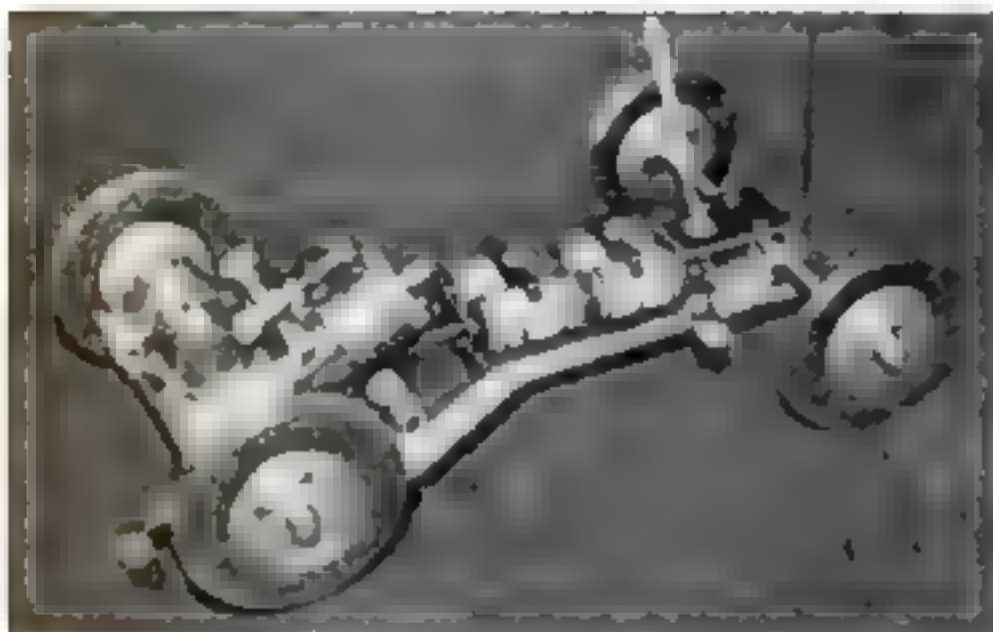
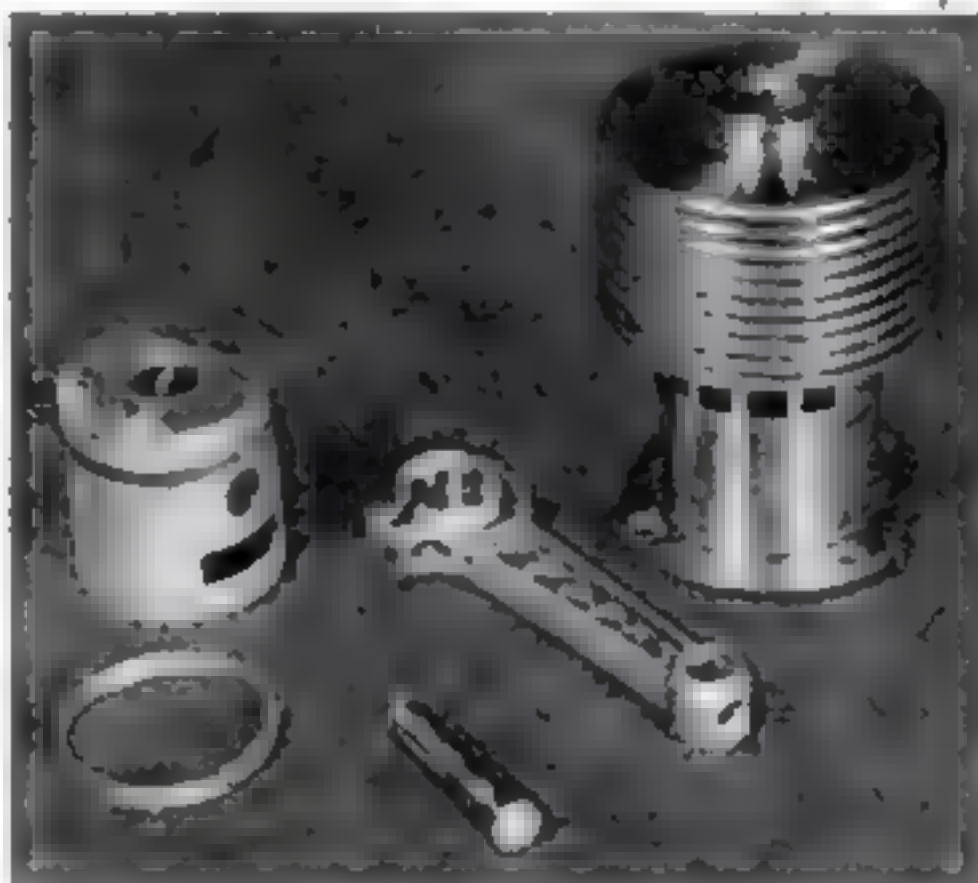
Care must be taken, however, to get a good radius of not less than $1/16"$ at the base of the spark-plug boss to avoid weakening the cylinder head. Also, since the outside diameter affects the cylinder-wall thickness, this should not be less than $1\ 3/32"$ at any point, nor should any fin groove be deeper than $1/8"$ for the same reason.

Parting in of the fins is done with a well-sharpened parting tool $.071"$ wide. In spacing the fins, the lathe compound is set exactly parallel to the ways. The parting tool is next set so it just touches the cylinder face, the lathe carriage locked, and the compound-rest collar set at zero. Then the tool is backed off with the cross feed and advanced $.101"$ with the compound feed for cutting the first groove. This leaves the fin $.030"$ wide. Repeat for each groove.

For proper depth, the tool is set just touching the $1\ 1/2"$ diameter of the work, the cross-feed collar set at zero, the tool advanced $.250"$, and a stop clamped to the cross-feed slide. Plenty of cutting fluid should always be used when parting.

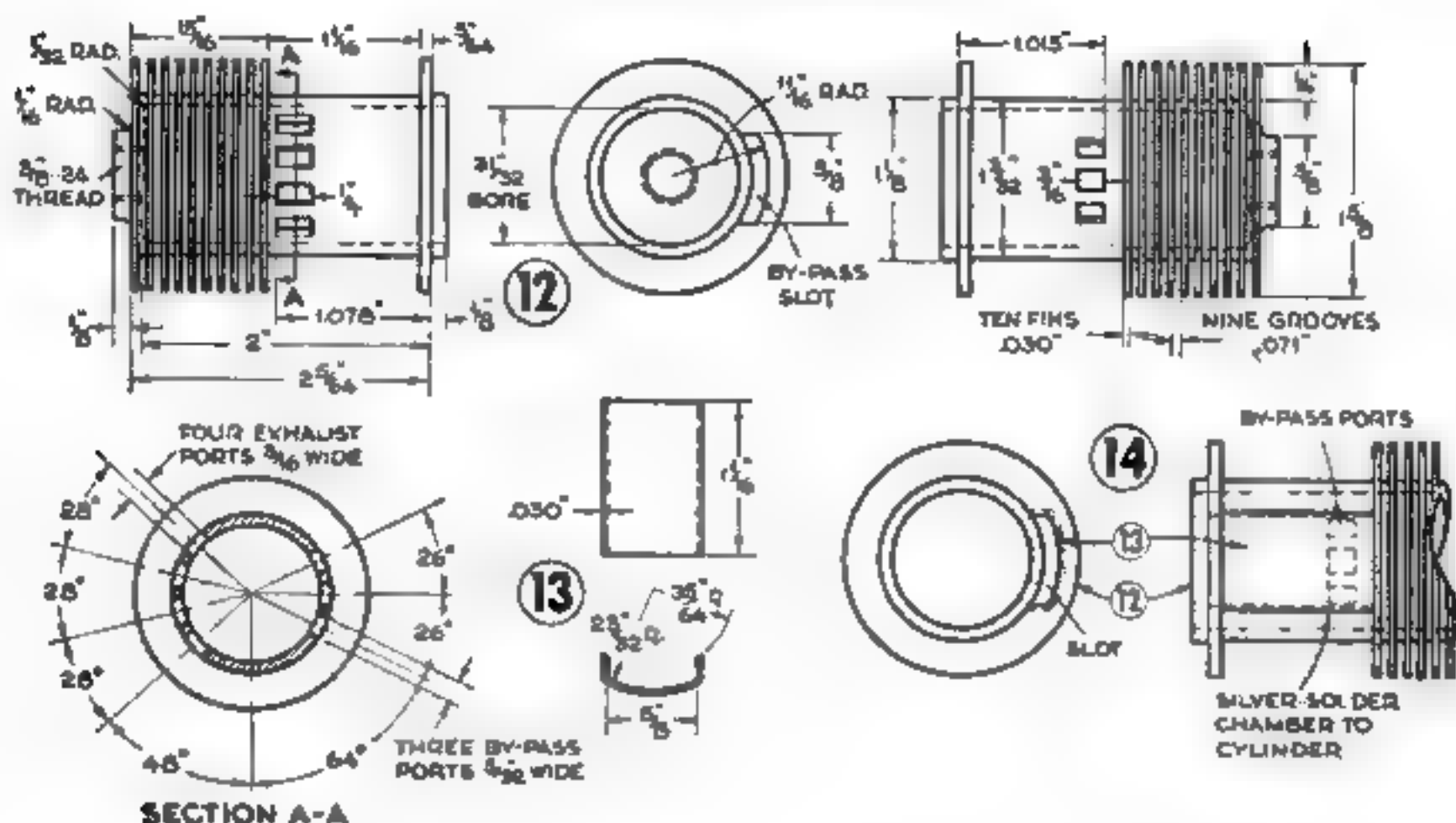
Note that the depth of the cylinder bore is measured from the lower face of the flange. Set the tool so it just touches the flange and lock the carriage stop with a $2.000"$ spacer intervening to get proper depth.

Use a good layout fluid and mark off the exhaust and by-pass ports and the by-pass



ROAD TEST in an experimental racing-car chassis. The engine shown, an earlier one built by Mr. Magee, only turned up to a free speed of 8,000 r.p.m. but pushed the car at 65 m.p.h. The engine described in the accompanying article has run free at 13,500 r.p.m., and Mr. Magee believes it will drive a racing car at better than 85 m.p.h. The new engine has a 20 per cent greater piston area.

WORK SHEET NUMBER FOUR



PART 12, CYLINDER

1. Face the stock to $2\frac{21}{64}$ " in length and rough-turn it to $1\frac{21}{32}$ " in diameter.
2. Drill a $\frac{1}{4}$ " hole straight through in the lathe, and drill a $\frac{3}{8}$ " hole $2\frac{1}{8}$ " deep, measured from the point of the drill.
3. Turn the work around and chuck with $1\frac{1}{16}$ " extending from the jaws. Bore the $\frac{1}{4}$ " hole to $.330$ " and tap with a $\frac{1}{8}$ "-24 tap for the spark plug. Turn a $\frac{1}{8}$ " diameter spark-plug boss $\frac{1}{8}$ " long, using a tool with a $1/16$ " radius.
4. Turn the fin section to $1\frac{1}{16}$ " diameter, and part in the fins to a depth of $\frac{1}{4}$ ".
5. Rechuck carefully on the fins so the piece will run true, and turn the $1\frac{1}{16}$ " length between the last fin and the flange down to $1\frac{3}{32}$ " diameter. Turn the flange to $1\frac{1}{16}$ " diameter and turn the $1\frac{1}{16}$ " diameter shoulder $\frac{1}{8}$ " long. The flange should be

$5/64$ " thick after turning at this stage of the work.

6. Bore the cylinder to $1\frac{1}{16}$ " in diameter for a depth of 2 " from the flange.
7. Lay out the exhaust and by-pass ports and the $\frac{1}{4}$ " slot in the flange. Drill and file to size.
8. Remove all burrs and sharp edges.

PART 13, BY-PASS CHAMBER

1. Form sheet stock over a forming block and file or machine to fit the cylinder snugly. The outer radius should be $1/16$ " less than that of the flange when fitted. Use only steel for the chamber.

PART 14, BRAZING ASSEMBLY

1. Assemble part 13 on part 12 so it will cover the three by-pass ports and the flange slot. Silver-solder carefully around the edges, using just enough solder to make the chamber airtight.

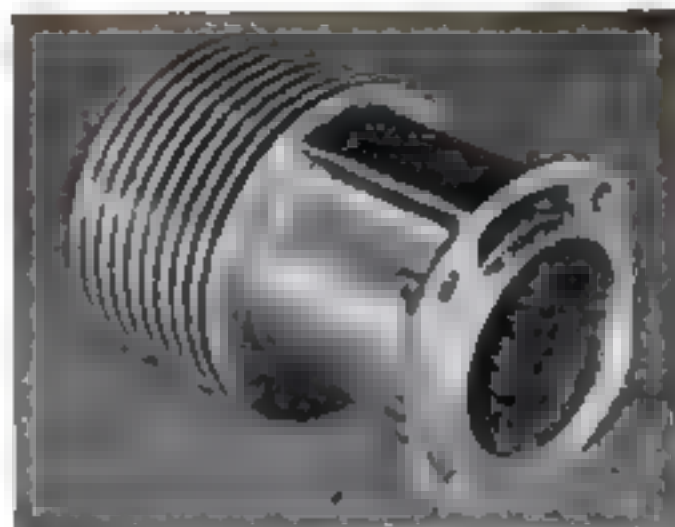
slot. An index plate or a 180-tooth gear mounted behind the chuck will determine the degrees (see P.S.M., Oct. '44, p. 185). The center of the by-pass slot is on a line with that of the middle by-pass port. Use a height gauge if available or a surface gauge to determine the port heights. Scribe the slot arc as a radius from the center of a plug put temporarily in the cylinder, or else scribe with a pointed tool while the cylinder is still chucked in the lathe.

So long as each group of ports is properly located in respect to the other, the width of the ports is not critical. The total of the three by-pass ports should not exceed, however, the $\frac{1}{8}$ " width of the by-pass chamber.

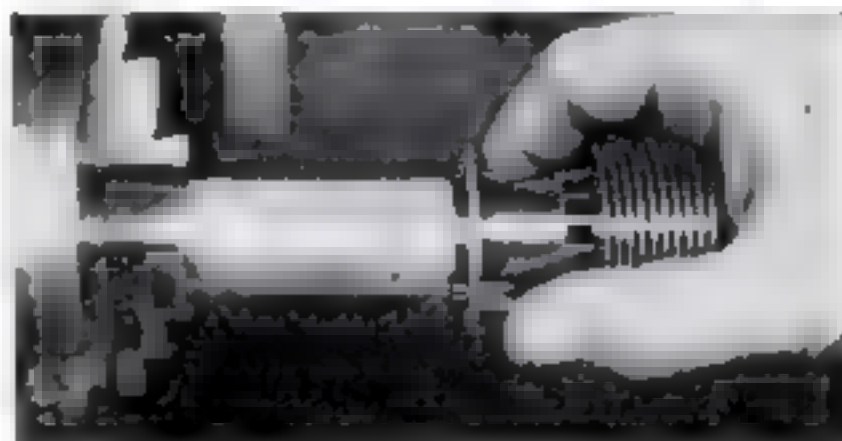
Locate the ports from the cylinder flange so they will be in proper position when assembled. This can be done by supporting the flange on two blocks of known height, say $\frac{1}{8}$ ", set up on a surface plate and adding $\frac{1}{8}$ " to the desired dimensions. A surface gauge may be used if no other more accurate lay-out device is available.

The 1.093 " diameter of the cylinder fits the 1.094 " bore of the crankcase (part 1), and clearance up to $.001$ " may be allowed. A snug fit is insurance against leakage. The $.004$ " clearance in the fit of the flange in the crankcase is not critical.

In boring the cylinder, it is well to examine the first few cuts to see that the tool

[illegible]

1. Chuck the assembled cylinder carefully and lightly on the fins so it runs true.
2. Turn the 1.093" diameter and face the flange to 1.062" from the top of the exhaust ports. Turn the flange to 1.590" diameter and face the cylinder end to leave the 7/64" shoulder.
3. Bore the cylinder to a fine, smooth finish, allowing .0003" to .0005" for lapping. Locate the 2.000" depth from the lower face of the flange. Use a 1/32" radius boring tool. Turn the 30-deg. chamfer.
4. Lay out and drill the four flange holes.
5. Mill or file the two flats to the 1 1/4" dimension.
6. File out the flange slot nearly flush with the 1.093" diameter, taking care not to mark or score this diameter or the cylinder seat.
7. Remove all burrs and sharp edges, including



After turning operations have been completed and the cylinder finish-bored, the bore is lapped to 1.000" diameter and a smooth finish. Here a lap is chucked in the lathe and revolved slowly.

those on the ports in the cylinder, before lapping.

8. Lap the bore to size.

9. Clean thoroughly to remove all traces of lapping compound.



To face the flange, set a sharp-nosed tool touching the top edge of one port, lock the carriage stop, and use a 1.062" spacer.



For boring accurately to depth, set the tool so it just touches the bottom of the flange. Set and lock the carriage stop with a 2.000" spacer between.

The two flange flats are milled or filed. They can be laid out by assembling the cylinder and crankcase with screws and scribing the crankcase width.



so the bore won't go too deep. Take care after finish-boring so as not to distort the cylinder in clamping or other operations.

Use a lead lap or one made of brass and solder. Chuck a length of 1" diameter brass in the lathe and turn it down to $31/32$ " for about $2\frac{1}{2}$ " from the end. [Turn the page.]

[illegible]

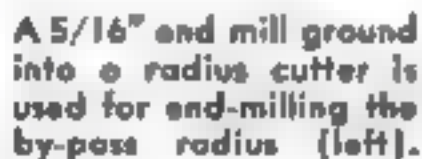
PART 17. PISTON RING

1. Chuck, bore to .935", turn to 1.055", and part off. Make several extra rings.
2. Grind to a width of .094".
3. Mill or saw the .040" slot.
4. Mount on the piston-ring arbor shown on page 161 and turn the outside to 1.000" diameter.
5. Polish the sides to fit the ring groove in part 16. remove burrs, and check for .005" clearance with the ring in the cylinder. File if the clearance is insufficient.

1. Chuck the stock, drill the No. 24 hole, and turn and polish to a diameter of .250".
2. Bore a .187" diameter 3/32" deep in each end.

1. Turn and part off

1. Press the caps into the ends of the piston pin and file or turn $\frac{1}{4}$ " radiuses on the ends. The overall length must not exceed $31/32$ ".



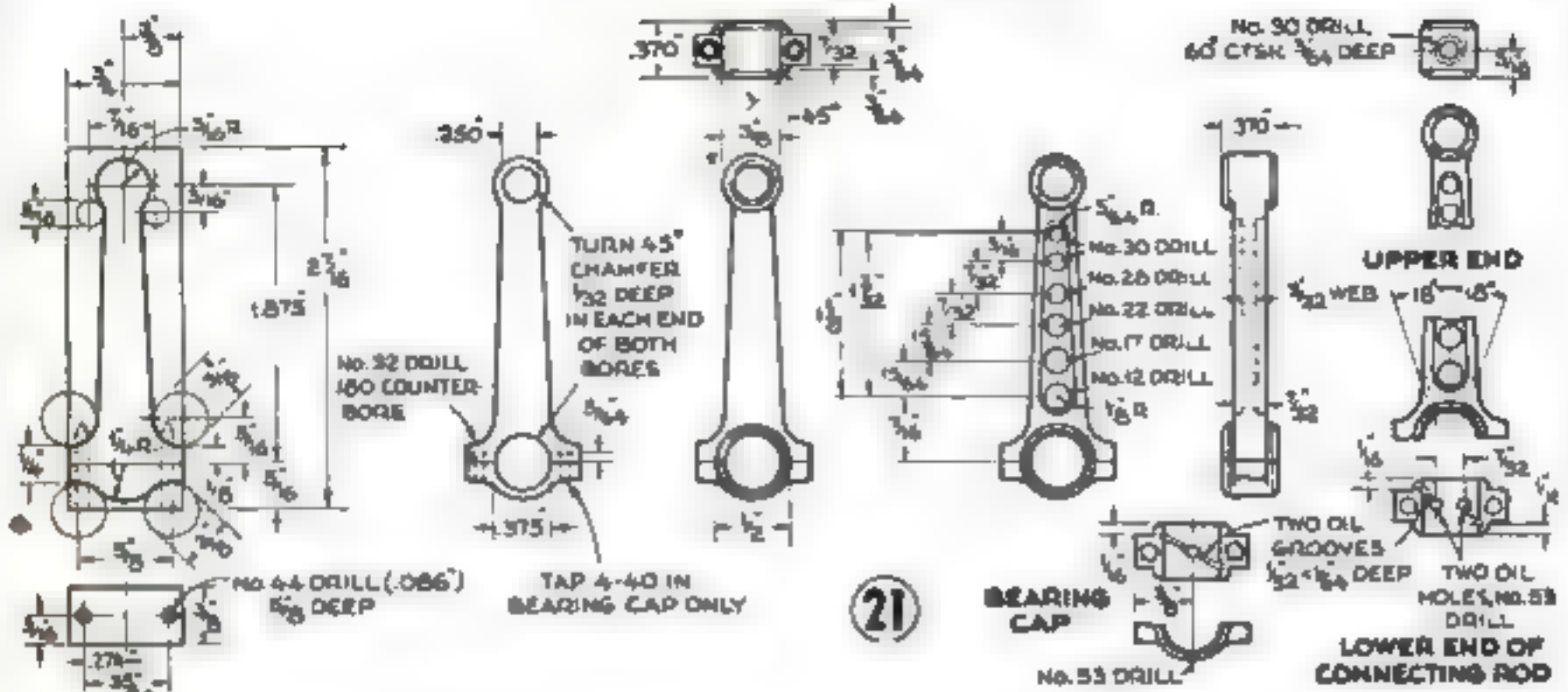
Finish-turning is done with the piston pressed on a stub orber turned to fit its two bores.

Rings may be ported off close to size (left) and polished on fine emery.

At right, using a feeler gauge to check the ring for .005" end clearance in the cylinder.



WORK SHEET NUMBER SEVEN



PART 21, CONNECTING ROD

1. Cut two pieces of stock, one $2\frac{1}{4}$ " long and the other $\frac{5}{16}$ " long. Machine the ends square, tin them, and sweat the two pieces together.
2. Lay out, as shown in the drawing.
3. Drill two No. 44 holes $\frac{5}{8}$ " deep in the end.
4. Saw and file the outside contour to size. Holes for the radiuses may be drilled if similar stock is clamped on the side where needed.
5. Prick-punch both parts so they will always be assembled in the same position.
6. Unsolder the parts and clean the tinned surfaces off with fine emery.
7. Tap the bearing-cap holes with a 4-40 tap.
8. Drill and counterbore the No. 32 holes in the connecting rod, as shown.

9. Assemble the cap and rod with two 4-40 socket-head cap screws $\frac{7}{32}$ " long, mount on the faceplate, and bore the $.375$ " and $.250$ " diameter holes.

10. Mount the crank end on a short arbor, face the boss to $.370$ " thickness, and chamfer the $\frac{1}{4}$ " shoulder. Then face carefully with light cuts to the $\frac{7}{32}$ " thickness halfway up the rod.

11. Mount the piston end on a stub arbor, face and chamfer both sides also to a $\frac{7}{32}$ " thickness, and face the remainder of the rod.

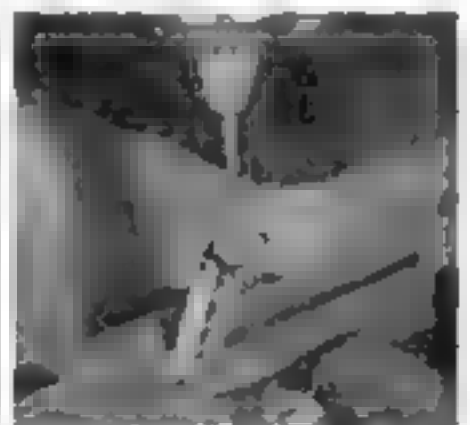
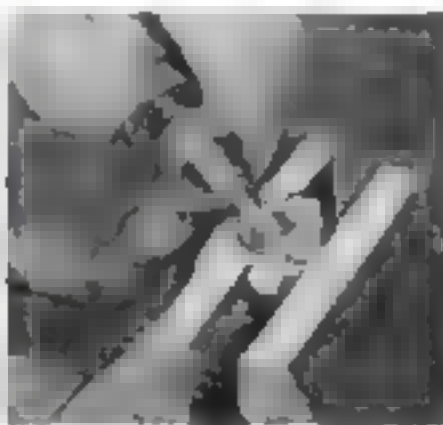
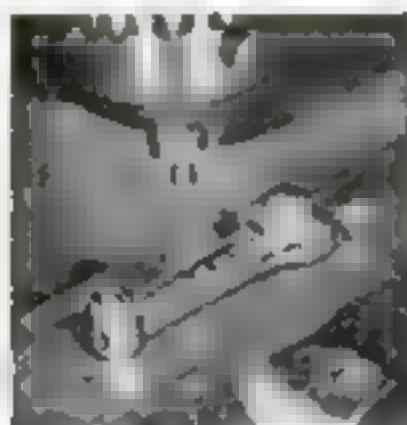
12. Lay out and drill six holes to lighten.

13. End-mill the H-section, leaving a $\frac{3}{32}$ " web.

14. Lay out and drill the three oil holes in the connecting rod and the oil hole in the cap.

15. Cut oil grooves in the rod and cap.

16. Remove all burrs and sharp edges.



Facing the boss and connecting-rod thickness in the lathe (left). One end of the rod is mounted on an arbor and then the other. At right, the H-section web is end-milled to size.

Oil grooves can be cut in the bearing cap with a hand grinder and small cutter, as at left above. Lay out and prick-punch for the two oil holes and clamp the rod at 18 deg. for drilling them.

Remove it and apply a film of solder to the turned portion while rotating it slowly over a gas flame, using just enough heat to make the solder stick without running to one side. When an even film of solder is obtained, rechuck the bar, turn the soldered portion

down to $.999$ ", and face off the end so the lap will reach to the far end of the cylinder. Then on the lapping surface apply a fine, even coat of No. 400 flour emery and light oil. Lap by running the lathe at slow speed and sliding the cylinder back and forth.

It is not necessary to bring the bore to exactly 1.000", for the piston and ring can be turned to correspond, but a true, smooth surface is important. If the lap wears down before the job has been completed, it can be resoldered and re-turned. All the compound must be removed by repeated washings when the work is finished.

Cut the piston-ring groove in the piston with a sharp parting tool .094" wide. Feed the cross slide in .0485" after touching the outside diameter with the tool and setting the graduated collar at zero. The corners must be sharp, sides straight and smooth.

Bore the piston-pin hole with the piston clamped to an accurately square angle plate, which in turn is clamped to the lathe faceplate with its inside face .625" from the center of the spindle. Check the setting with scrap stock, boring a .250" hole and setting the cross-feed collar at zero after the last sizing cut. A .250" dowel pin is a good gauge.

Extend a .250" dowel pin through the piston-pin hole and locate from it to lay out the exhaust chamfer and by-pass radius on the piston head. Then stand the piston on its head and mark off the $\frac{1}{8}$ " depth. In end-milling inside the piston to lighten it, be careful not to cut closer than $\frac{1}{32}$ " from the piston-pin holes, leaving the bosses there to support the pin. Locate the slots from the holes so they will be centered.

The stub arbor on which the piston is finish-turned must be a snug fit for the $\frac{15}{16}$ " diameter, and must have a shoulder to hold the piston square. Turn the piston

to a smooth finish that fits the cylinder with a clearance of .003".

If a grinder is not available, the piston rings can be parted off close to size and polished down to .094" with fine emery cloth laid on a flat surface.

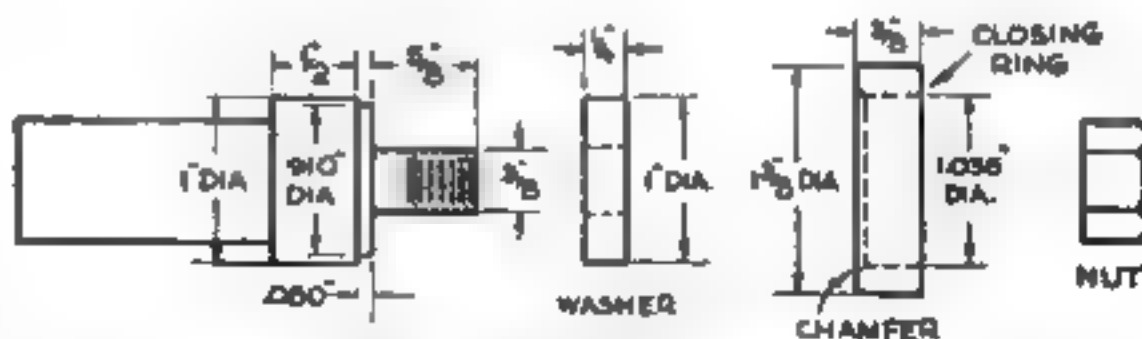
Sweating the two parts of the connecting rod together helps in aligning the two screw holes, which must be laid out accurately and drilled square with each other and with the sides of the block. Keep matching surfaces flat and square when polishing off the tin after unsoldering. Counterboring requires care and a very fine feed because the cut starts on a sloping surface. The counterbore shown below should be tried first on scrap stock.

A flat auxiliary plate may be needed under the rod for support over the faceplate when the holes are bored in the crank and piston ends. If toolmaker's blocks are available, they help in obtaining the 1.875" dimension between centers. However, an error up to .005" should not cause trouble. Bore the crank-end hole accurately; the other a free but not loose fit on the piston pin. A little oil in the bores when they are mounted on the arbor will prevent scoring.

When the piston and rod are assembled with the piston pin, the distance from the center of the crank-end hole to the extreme top of the piston should be 2.309" to 2.312". If it is less, hope for the best or make a new part. Should it be greater, take a cut off the top of the piston and correct the exhaust chamfer and by-pass depths to maintain proper port action.

LIST OF MATERIALS

| Part No. | Description | Size |
|----------|-----------------|---------------------------------------------------------|
| 12 | Machine steel | 1 $\frac{3}{4}$ " dia. by 3 $\frac{1}{2}$ " |
| 13 | Sheet steel | .036" by 1 $\frac{1}{8}$ " sq. |
| 16 | Dural | 1 $\frac{1}{8}$ " dia. by 3" |
| 17 | Gray cast iron | 1 $\frac{1}{4}$ " dia. by 3" |
| 18 | Drill rod | 5/16" dia. by 1 $\frac{1}{2}$ " |
| 19 | Dural | $\frac{1}{4}$ " dia. by 1 $\frac{1}{2}$ " |
| 21 | Phosphor bronze | $\frac{3}{8}$ " by $\frac{1}{4}$ " by 2 $\frac{3}{4}$ " |



NOTE: PLACE PISTON RING ON .080" SHOULDER, HOLD SHUT WITH CLOSING RING, CLAMP WITH WASHER AND NUT. REMOVE CLOSING RING AND TURN PISTON RING TO SIZE.



NOTE: HARDEN AND DRAW CUTTING END ONLY. TRY CUTTER IN SCRAP STOCK TO CHECK SIZE AND ACTION. THE $\frac{5}{16}$ " LONG UNDERCUT IS TO CLEAR $\frac{3}{8}$ " DIA. TOP BOSS OF CONNECTING ROD.



Photographer and pilot must work as a team to obtain successful photos.

Hitch Your

THRILLS AND NEW ANGLES

By CHARLES SMITH

WHILE shooting pictures from a plane, you can forget some of the factors that must be kept constantly in mind in ordinary photography. For instance, focus. In the air, you set your camera at infinity—and leave it there. If you go so close that your subject is not in focus, *you're flying too low, brother!*

Neither do you have the problem of arranging lights for the best effect. You just fly around the subject until you find what you want. Exposures remain rather constant, too, for on a single trip light conditions seldom have time to change much.

Everything considered, successful aerial photography depends to a large extent on whether you and your pilot select the right angle and put the plane there. I have often observed how frequently two aerial photographers, operating several years apart, will shoot a building from the same angle and come back with almost identical negatives. For that reason, it is a good idea to try for an unusual angle along with the

standard views that every other photographer may bring back.

Other points to remember: emphasize cross lighting to show structural details, shoot straight down on the subject to show the ground layout, and overprint surrounding objects to make the subject stand out strongly.

Photographs can be taken from practically any plane. My preference is a high-wing ship, particularly when I am working without a pilot, for it does not have to be banked steeply to keep from shooting the wing. However, with a competent pilot I have had good results from the rear cockpit of a Fairchild 19 Primary Trainer. Some aerial photographers seem to like planes modeled along the lines of the Culver Cadet, but you have to bank rather steeply and it is not easy to shoot in this position with the plane throttled back.

Photographs can be made from any hole large enough to poke out the lens and view finder. From a small opening, however, the plane must be put in exactly the right position, for you have no room to swing the

camera around to find the subject. The more room, therefore, the better.

With the Cub Trainer you can open the door and grab a shot ahead of the strut and then another after the strut passes over the subject. With such side-by-side coupes as the Taylorcraft or Aeronca, I have frequently removed the window and carried along a piece of plastic in case it should become too cold. Some other planes have windows that pull down fully, allowing sufficient camera room.

Generally speaking, unless you have a long distance to travel, a slow ship is best. Fast planes just increase the speed with which your subject goes past the view finder, lessening the possibility of sharp negatives. You also have less time to compose your shots.

Photographers sometimes tell dramatic tales of hanging out of a plane to shoot pictures, but such a practice is almost never necessary. In the first place, the slip stream

will cause the camera to vibrate and move enough to blur almost every shot. In the second place, the slip stream may tear the bellows if your camera has one.

Try to work with a pilot who is interested in what you are doing and talk it over with him before you take off. Most experienced pilots have flown photographers on several occasions.

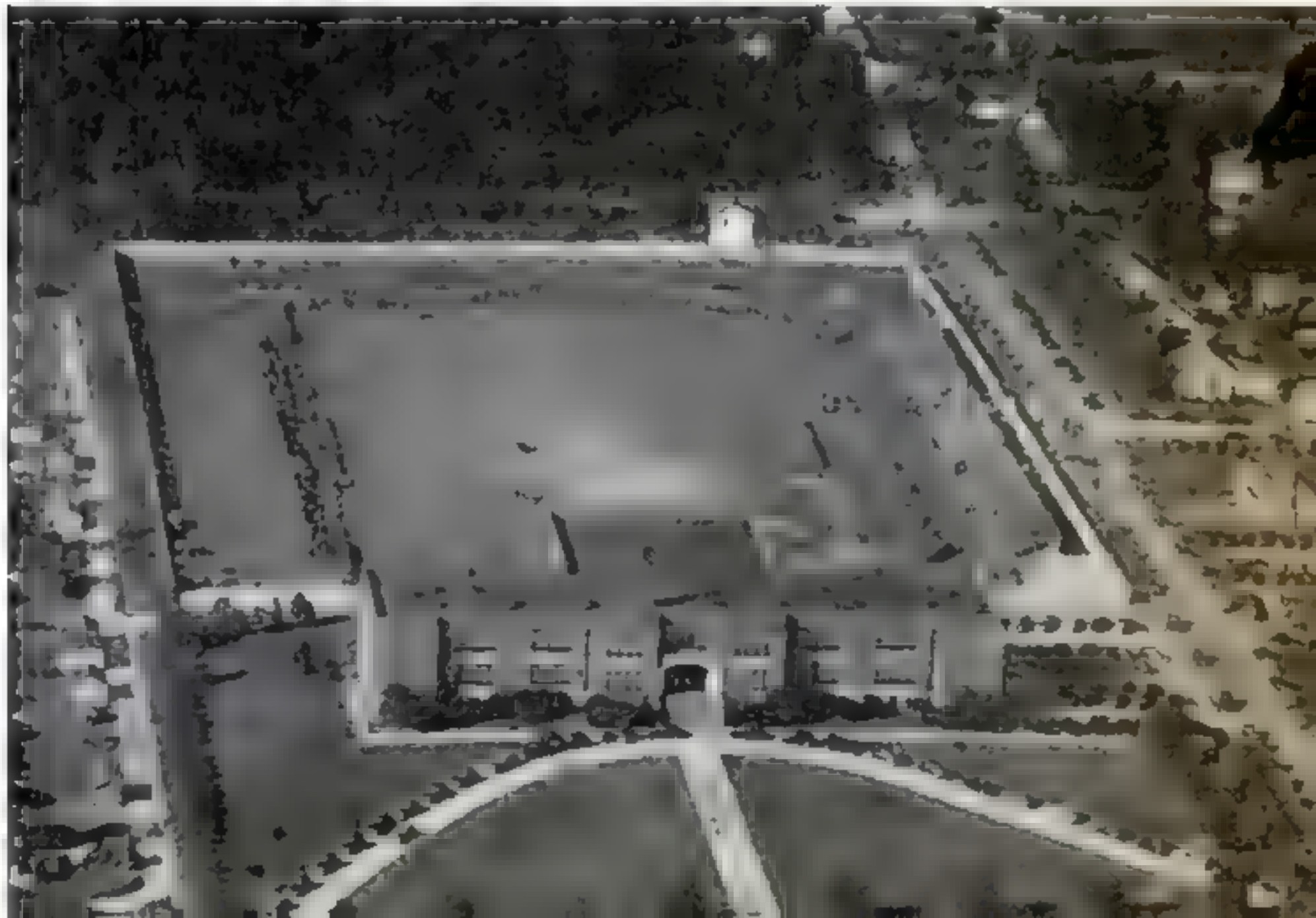
If you travel on a commercial air liner, do not overlook the possibilities of pictures. Take your camera along and try to get a seat well in front of the wing or behind it. If you are in doubt about the best spot, the stewardess probably will help you.

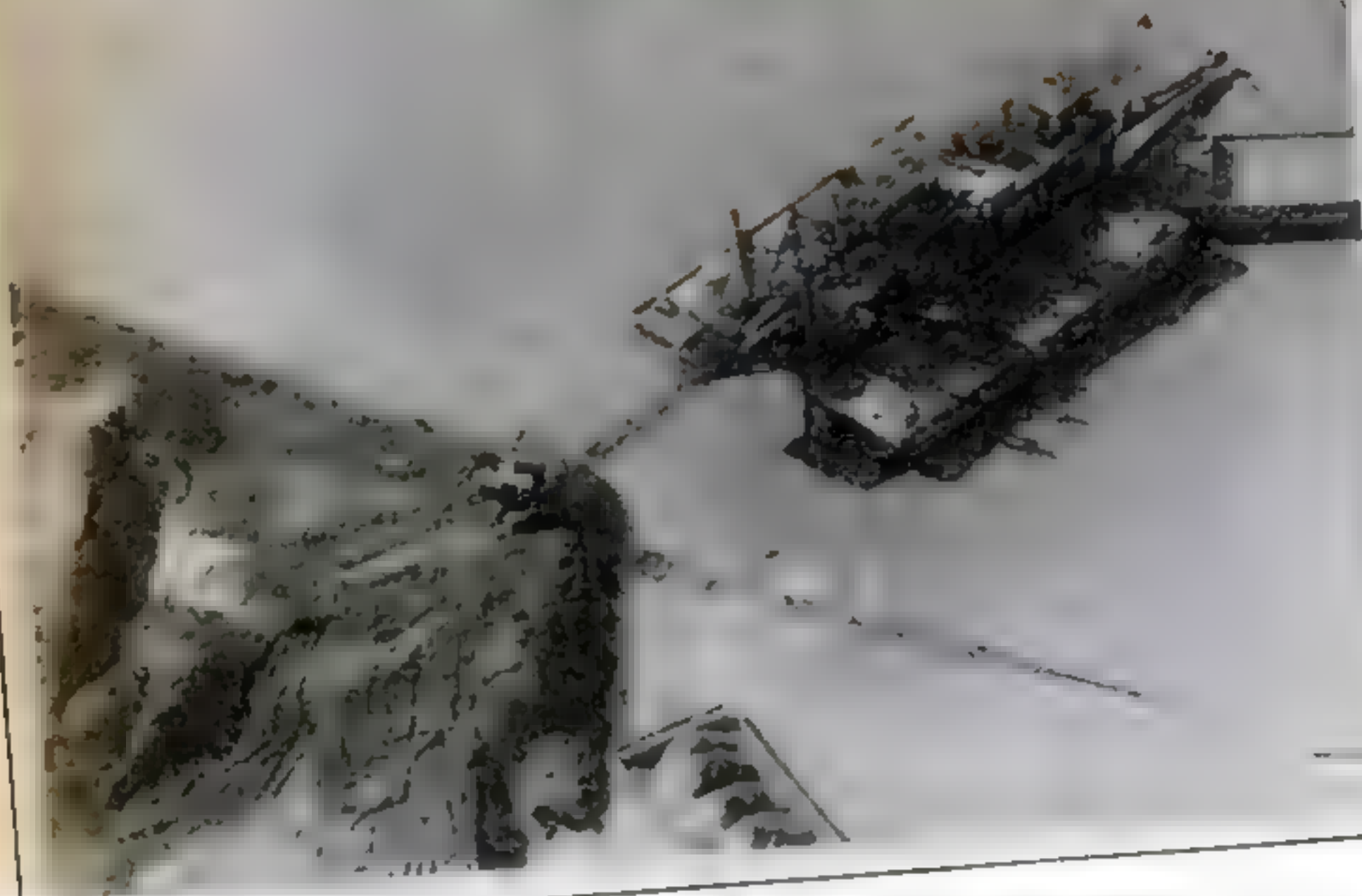
The kind of camera you use in aerial photography is not particularly important, though of course a long-focus lens is a help. It's a good plan to use a minimum shutter speed of 1/100 sec. and higher speeds whenever you can. I try to shoot at 1/400 sec. or faster, but I get good results at 1/200 sec. when conditions make it neces-

Camera to a Plane

ON PHOTOGRAPHY AWAIT AIRBORNE CAMERA FANS

Exposures must be fast. Snapped from 1,000' at 1/300 sec., this view of a football game has fine detail.





This dredge was snapped from 800' with a 135-mm. lens and a Contax camera at 1/500 sec. and f 5/6.

sary. Close the aperture down as many stops as you can.

Panchromatic film is essential to good air views, for green grass and trees will show little detail on an ortho film. For low-altitude work, filters will give your negatives a little extra snap, but the days that are dull enough to need this extra sparkle will also be dull enough to require the speed you must sacrifice for the filters. Aerial haze generally begins at about 100' but it is not usually serious at low altitudes.

Vibration of the camera is perhaps the greatest single cause of failure in aerial photography. Vibrations are imparted to the entire plane by the engine. Although slight, these are so fast that no shutter speed will overcome them. In shooting a picture, the trick is to keep the upper part of your body and the camera from touching the plane. This allows the lower part of the body to absorb vibration before it gets to the camera. You will soon learn to hold steady without bracing yourself.

Should the air be bumpy, you can ask

your pilot to throttle down after he gets the plane in the position you want it. And it will help if he pulls the nose up a little to lose forward speed. He will have to be the judge of how close he wants to approach a stall. That probably will depend on how high he is.

Because of the large number of exposures that you can make in a short time, a 35-mm. camera is fine for aerial photography. Roll-film cameras of all kinds also are handy. Film packs are more satisfactory than holders when cut film is used, for the film is much easier to change. You will quickly find out what I mean if you are alone in a plane on a rough day trying to handle the plane with one hand and change holders with the other.

A precaution that I strongly recommend is to fasten your camera securely to the plane with a cord or strap. If the camera should be unexpectedly caught in the slip stream, you might otherwise lose it.

Darkroom work for aerial photography is not difficult. I aim for a little more than

normal contrast, but some photographers want it slightly less than normal. This is chiefly a matter of taste, but in some cases the purpose for which the photographs are intended may have a bearing. Additional contrast usually will make your photographs more catchy to the eye, but this will result in the loss of detail in the extremes of dark and light areas.

In aerial as in other types of photography you will be wise to set up some standards for yourself right at the beginning, and to destroy those negatives and prints that do not come up to par. There always will be times when the plane hits a bump at the same instant you squeeze the shutter, blurring the entire negative, but these occasions will get farther and farther apart as you keep clicking away.

During the war, the value of aerial photographs was obvious. There are many peacetime uses for air views, too, and you will find that many individuals and business concerns will be glad to buy the photos you can provide. Real-estate dealers use

them to show clients their prospective homes in relation to the surrounding neighborhood. Municipalities find them useful in city planning. Educational institutions and industries employ them for advertising purposes. Almost any householder would like an air view of his home.

No matter where you live, there still are a lot of good pictures in the air, just waiting for someone to take them. Besides building up a pleasing file of pictures, you will see, from your magic carpet, scenes of almost breathtaking beauty.

So, if you are a photographer and like to fly, you can do both and have a lot of fun—as well as make it pay.

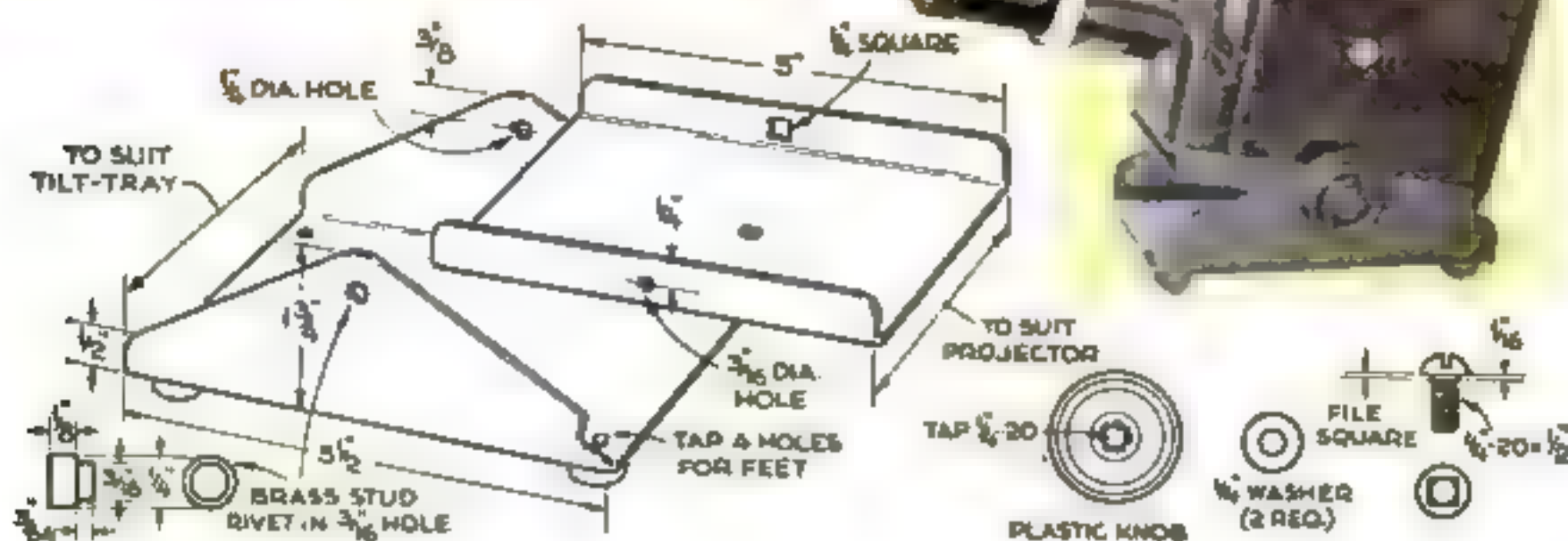


Cross lighting reveals the structural details of the building above. Such a photo is often useful to an architect.



Industrial plants with smoking chimneys make dramatic subjects for aerial pictures. They always are in demand.

PHOTO IDEAS

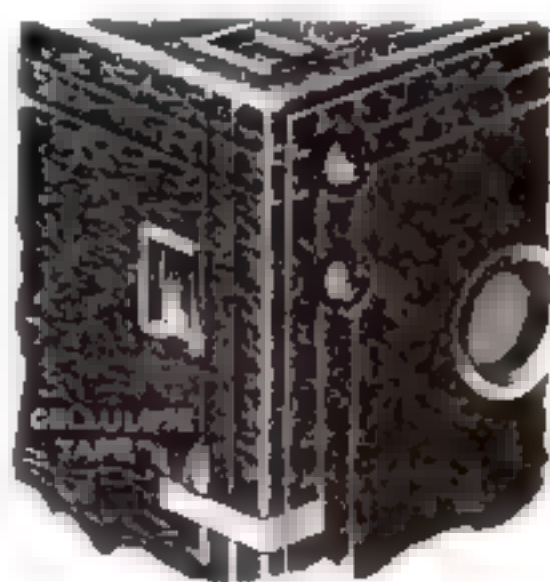


A TILTING STAND for a slide projector is a great help in centering the image on the screen. One can be made, as shown above, from 1/16" sheet steel or brass. After cutting out the base and tilting tray or table, bend them to shape with a mallet over hardwood blocks. Drill and tap the indi-

cated holes, and file square part of the head of a $\frac{1}{8}$ " machine screw to fit a matching hole in one side of the table. Also tap the brass insert in a radio knob for the machine screw. Assemble as shown, and screw or otherwise fasten the projector to the tilting table.—KARL HALLER.

ENAMEL MARKINGS that have flaked off a thermometer can be restored by coating with the acidproof black paint sold in photo stores. After a minute or so, wipe with a cloth dampened with turpentine. Paint will remain in the markings.—WILL THOMAS.

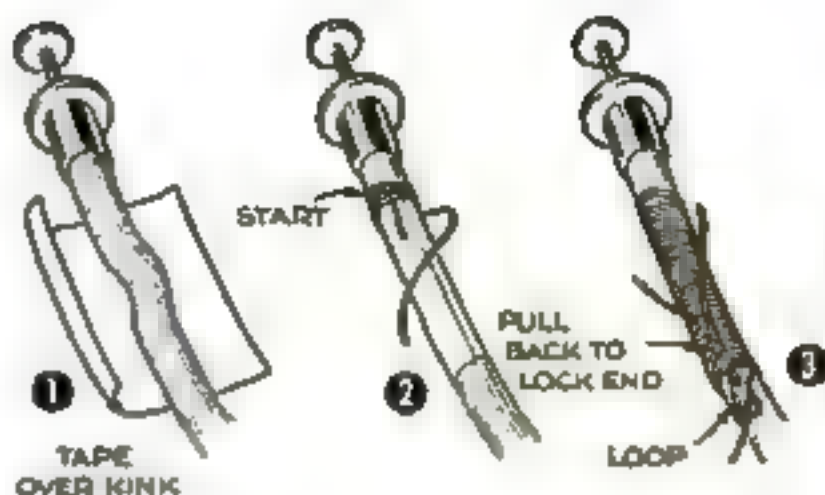
TWO-FRAME LENGTHS of 35-mm. film, held flat in this glassless negative holder, can be handled without difficulty in your enlarger. The deep notch in the upper piece lets you hold the negative securely in place while the holder is assembled. Scrap 16-gauge aluminum, carefully filed to size, serves as material. The locating pins are 3/32" rivets, upset just enough to stay in place. Swivel pins act as clamps.—J. M. K.



CELLULOSE TAPE placed across the shutter-lever slot in a box camera, as above, will prevent the shutter from being tripped accidentally and spoiling film. When the camera is to be used, remove the tape. After the picture has been taken, replace the tape to prevent further shutter action. Tape of the reusable type will be most convenient for this purpose.—J. K., Jr.



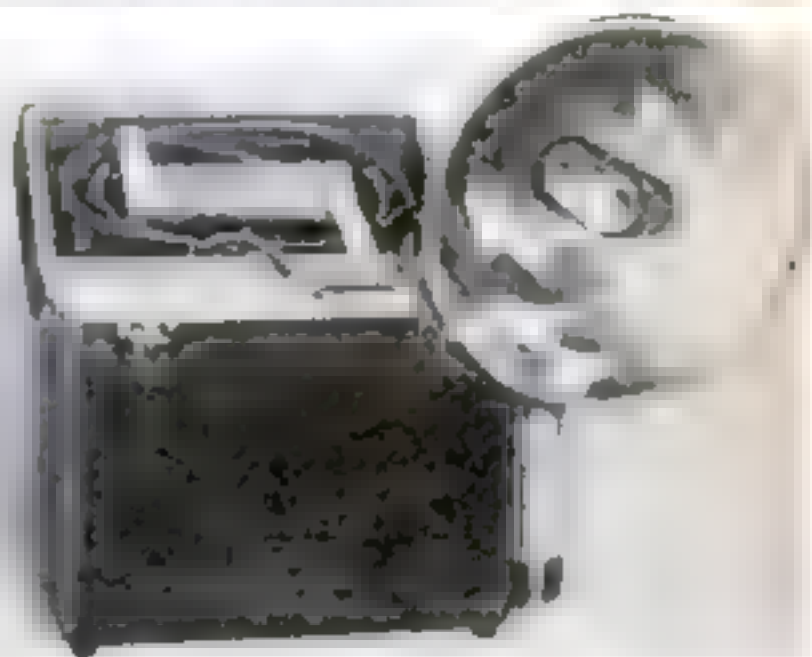
LIGHT WHERE YOU WANT IT and from the angle you want it often is a photo problem. One solution is to adapt flexible goosenecks from desk lamps to the stands at hand. Since most goosenecks have a $\frac{1}{8}$ " pipe thread at one end, they can be attached to the center rod of the stand with a tee and street elbow. This allows the outfit to be collapsed for portability. Flood or flash bulbs may be used in the brass socket of the gooseneck with any type of reflector that you may need.—IVAN GROSVENOR.



KINKED CABLE RELEASES may be saved with the repairs illustrated above. Wind friction tape over the kinked area (Fig. 1) and strengthen with black silk thread lashed over the tape, securing the starting end with the first turns of the thread (Fig. 2). Bind the final end with a separate loop of thread (Fig. 3). Finish the job with a coat of black wax shoe polish.—G. E. H.

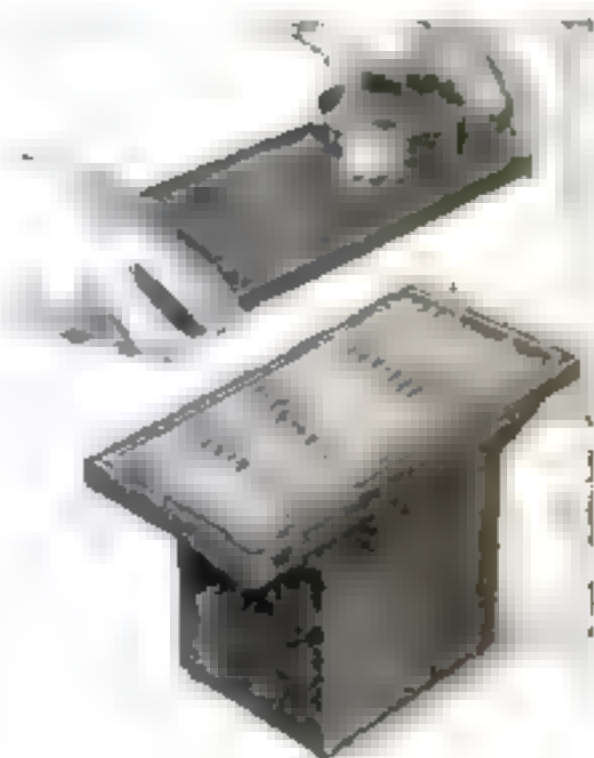
NEW PHOTO EQUIPMENT

AN ELECTROFLASH UNIT announced by the Wabash Corporation, Brooklyn, N. Y., produces 10,000 flashes with a single repeating bulb. Operating from any 115-volt A.C. line, the 21-lb. unit consists of a power pack, flash gun, and a bulb having an effective flash duration of $1/5,000$ sec. This blue-white flash approximates daylight and has a Kelvin temperature value suitable for daylight color film. Within 7 sec. after each flash, the unit automatically recharges itself and is ready for use again.



LIGHT AND STURDY, a dural table-top tripod introduced by the Tikern Corporation, of New York City, is marketed under the trade name of "Ped-A-Still." It weighs 6 oz. and stands 12 $\frac{1}{2}$ " high.

LIGHT-TIGHT VENTS permit this daylight sheet-film tank to be emptied or filled in 32 sec. It can be used in bright light after being loaded in darkness or under a safelight. Price Industries Corp., of New York City, manufactures the tank.



Listen in on the hams with this **10-METER BAND RECEIVER**

By Clinton Clark

TEN-METER phone reception and transmission have long been popular with radio hams because this channel is good for both long-distance and local communication. When the end of the war made it possible for communications authorities to turn on the green light, amateurs all over the world reopened ten-meter transmitters, and lost little time in contacting old friends, far and near.

If you tune in tonight, there's a good chance that you can pick up Algeria, England, or the Philippines. Yes—you can tune in tonight, for this receiver, reduced to bare essentials, will take very little of your time to build. It is intended to open the door of a fascinating spectrum to the beginner, and invites experimentation on other short-wave bands through the use of easily made, interchangeable coils.

First step in construction is the base which, in this case, is a $\frac{3}{4}$ " by 7" by 7" pine board, sanded and coated with clear varnish. Details of the condenser-tube-coil assembly are not critical, but the layout illustrated in the photographs is suggested because it allows for short connections. Low-loss insulation and direct wiring are very important in all high-frequency circuits.

The tube upright is a $2\frac{3}{4}$ " by 4" strip of composition board. Bore a $1\frac{1}{4}$ " hole to take a five-prong ceramic tube socket. Another piece of composition board, 3" by $5\frac{1}{2}$ ", is used as an upright for the coil-and-condenser assembly. In the center of this panel mount a midget 15-mmfd. tuning condenser. Bolt a $\frac{3}{8}$ " strip of bakelite or other low-loss material to the edge of the upright, and drill three holes for tip jacks. When fastened into place, these jacks form a socket for the coil ends and tap.

Arrange the two uprights at a 90-deg.

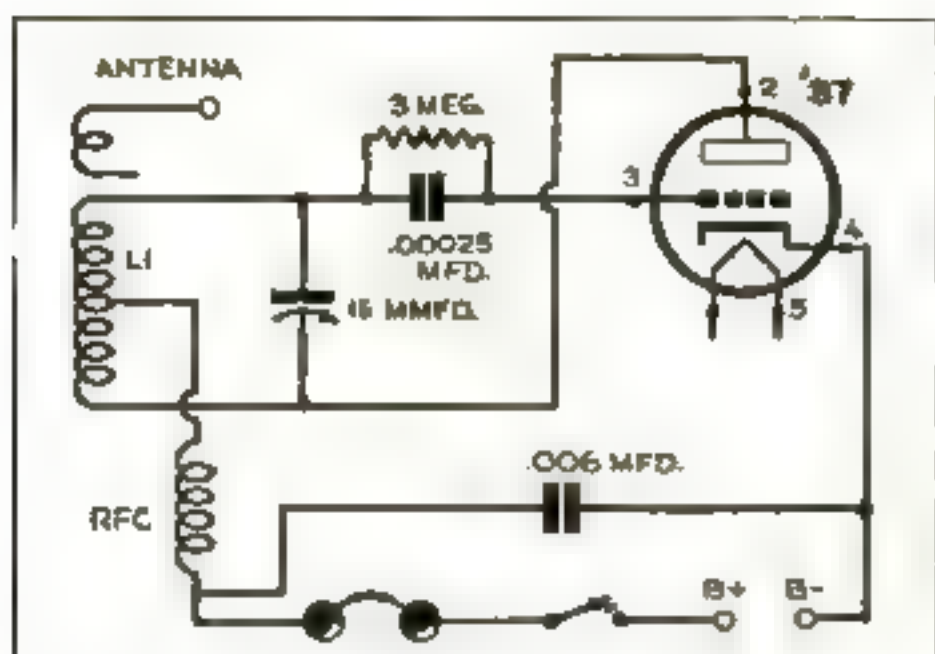


Fewer than a dozen electrical parts went into this short-wave receiver. It takes very little space, although no special attempt was made to keep it compact.

Skip-distance effects are very marked on the 10-meter band. Don't be surprised if your set pulls in stations 5,000 miles away more readily than those only 500 miles from you.

angle to each other by screwing them to a square wooden subbase. This is later screwed to the larger base. Now make the short connections from the coil terminals to the condenser and tube socket. Attach the radio-frequency choke to the smaller square. The choke may be purchased, or hand wound on a $\frac{3}{8}$ " dowel. If you prefer the latter, drill a $\frac{3}{8}$ " hole in the subbase to receive the dowel, and wind it with 100 turns of No. 34 D S C. wire.

For the front panel, a 7" square of composition board is screwed to the base. Drill holes for the dial, switch, antenna binding post, and phone jacks. Make sure that the hole for the dial is aligned with the condenser shaft. Since approximately 3" is allowed between the front panel and the condenser subpanel, a coupling will probably be needed to connect the knob and the condenser. The distance, plus a fiber or plastic coupling shaft, helps to prevent the introduction of hand capacitance.



To make the coil, L1, wind 30 turns of No. 14 solid copper wire on a $\frac{1}{2}$ " form. When the form is removed, you have a self-supporting, low-loss coil. Solder the coil ends into phone tips to fit the jacks used as sockets on the subpanel. The tap may be of flexible wire soldered approximately a quarter of the distance from the plate end of the coil. Phone tips and jacks make a good coil-mounting combination; a dozen or so tips cost but a few cents, and will enable you to make additional coils for trial on other bands. Some experimentation may be necessary to locate the best spot for the tap, because of the individual characteristics of many high-frequency elements.

A type 37 tube is used, requiring a 6-volt A.C. or D.C. filament supply. If it is more convenient to operate the heater off a 2½-volt supply, substitute a type 27 tube.

When wiring is completed, apply the filament voltage, then turn on the switch in the plate circuit. Either a 90 or 135-volt B

supply may be used, the higher voltage, of course, providing greater output.

A loud, hissing noise, characteristic of all superregenerative receivers, should be heard in the earphones. As a station is tuned in, this hiss will be blocked out or recede into the background.

A good high-frequency antenna is recommended for best results. It may be coupled into the circuit by placing two turns of stiff, insulated wire near the grid end of the tuning coil, as shown. Alternatively, a hairpin loop of wire from the antenna binding post may be inserted directly into the grid end of the coil.

For convenience, the battery connections are grouped in a single terminal strip, illustrated in the photograph at the upper left, but omitted from the diagram.

Best reception on the ten-meter band can be expected during daylight hours. It is, however, subject to strong interference due to seasonal and atmospheric changes.

Capacity Bridge for Testing

By GEORGE O. SMITH

TO MOST casual radio experimenters, condensers are a bit like electric-light bulbs: either they're good, or they're bad, and it's not hard to tell which. In a majority of cases this rule-of-thumb works out pretty well. An ohmmeter or a simple neon tester tells you all you need to know for a quick decision.

One vital fact about a capacitor, however, is neglected by these oversimplified tests—its capacity. This useful instrument fills the gap, and makes possible many refinements in radio testing and construction. It does it by telling you the value of an unknown condenser.

No provision is made for testing shorted condensers, as these may be readily checked with an ohmmeter. "Open" condensers show up, however, since they have only a small fraction of their rated capacity.

The theory of the bridge is simple. Figure 1, below, shows a basic form of Wheatstone-bridge circuit, with all resistors equal. Current flowing through the members of the bridge divides equally, and no voltage difference exists across the meter. Lowering one resistance, say R1, produces the unbalanced condition illustrated in Fig. 2. The division across the lower pair remains the same, since these resistors are unchanged, but the altered proportions in the upper half cause a voltage increase at the junction. The meter reads the difference between the two junction voltages. If R2, the corresponding resistor in the lower pair, is reduced proportionately, the junction

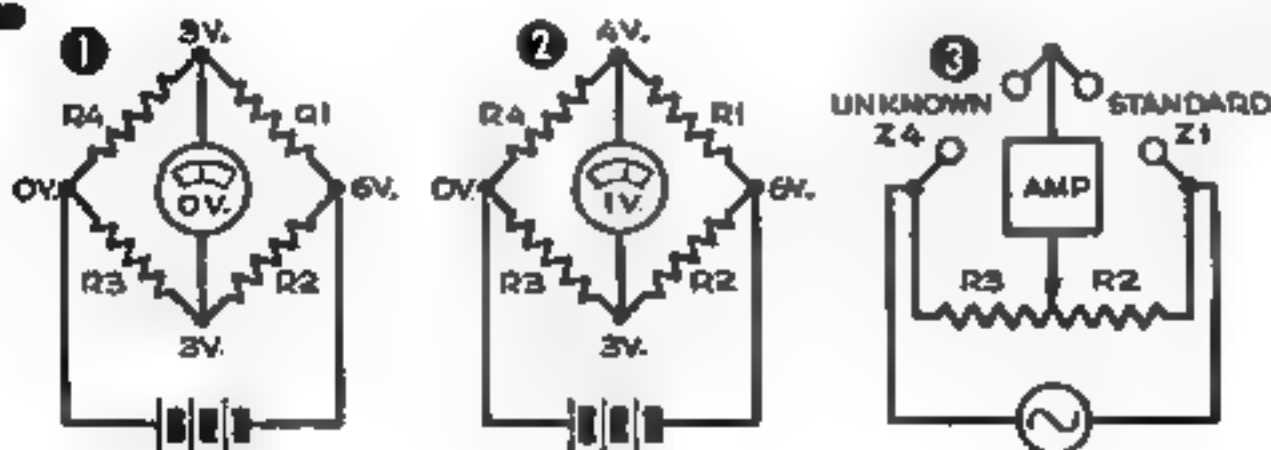
voltage will again be equal, although not necessarily at half the input

Combining the lower divider into a single potentiometer makes possible a wide variation in division ratios. That is the basis of the capacity bridge. Since, however, capacitors will not pass direct current, the batteries represented in Fig. 1 and 2 are replaced in Fig. 3 by an alternating-current source. Any A. C. voltmeter could, theoretically, be used to complete the bridge, but in practice few would prove sensitive enough for the job. This is particularly true since voltage difference becomes extremely small near the balance point. Therefore the meter is replaced by an amplifier that drives the 6E5 indicator tube.

In the schematic diagram on page 192, the bridge circuit may be traced out, although its configuration is not very clear. Potentiometer R1 obviously replaces R2 and R3 of Fig. 3, and the "standard" impedance, Z1, corresponds to the condenser selected by switch S1. This switch allows the use of three continuous ranges from 10 micromicrofarads to 10 microfarads, covering all the condensers used in most receivers. It is possible to calibrate the dial for still broader coverage, but this will result in decreased accuracy.

The "unknown" side, Z2, consists of any capacitor connected across the test terminals. A 5-volt winding of a power transformer is used as the A. C. source.

One side of the 6SL7 is connected as a high-gain amplifier, the other side as a rectifying diode. To give good sensitivity on the low-capacity range, R4 is made quite



When all resistors are equal (Fig. 1), the voltage across the Wheatstone bridge divides so that the meter reads zero. An unequal division obtains when R1 is reduced (Fig. 2). Lowering R2 or R4, or raising R3, will tend to re-balance the bridge, since $\frac{R1}{R4} = \frac{R2}{R3}$.

Condensers

large. Output from the amplifier is coupled to the diode through C4. This value is not critical. A 1-mfd. condenser is specified, but anything from .25 mfd. to 4 mfd. may be substituted.

When the unknown capacity is out of balance with the known, the available A. C. is amplified in the first section and rectified in the second, placing a positive voltage on the grid of the 6E5 indicator. Potentiometer R2 is used to adjust the eye of the tube to an almost-closed position, since this is the most sensitive part of the 6E5 operation curve.

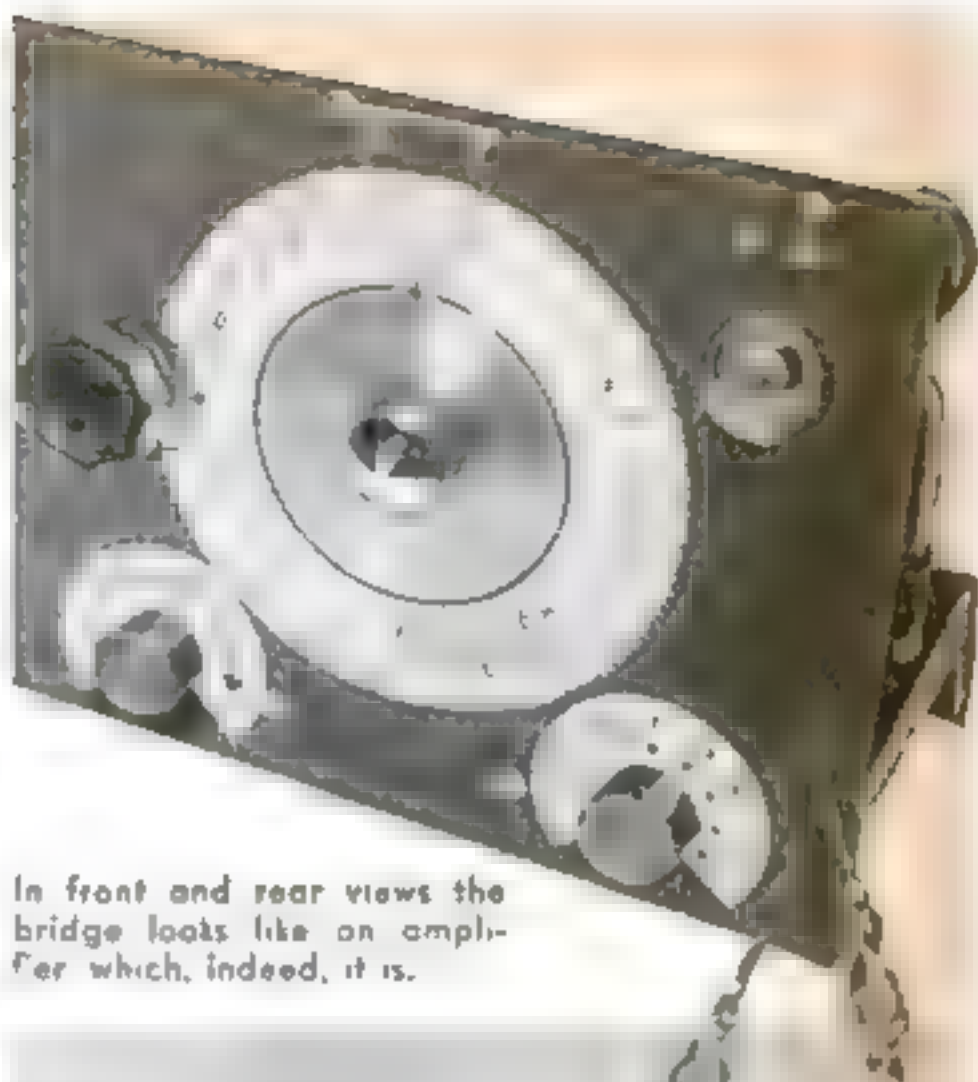
Most of the components are noncritical, but the three bridge condensers, C1, C2, and C3, should be as accurate as possible. The additional cost of capacitors having close tolerance will pay off in increased accuracy.

A standard small transformer is used for the conventional power supply. By using a 6X5 rectifier that will operate off the 6.3-volt winding, the 5-volt section is left free for the bridge supply. All three tubes share the same heater power; do not ground them at the sockets, but run a twisted filament line through the chassis and ground the entire circuit at pin 8 of the 6SL7.

The center arm of R1, and the "adjust" position of the range-selector switch are grounded at the same spot on the chassis, along with a number of other parts. This practice minimizes chassis currents, which are capable of causing trouble in the balance of the bridge. Filter C5, C6, and R6 is used to smooth the rectified output of the detector diode so that the grid of the indicator will be furnished with D. C. proportional to the unbalance of the bridge.

Range selection is accomplished by means of a two-pole, five-position switch, but the line-switch portion may be replaced with a simple toggle, and a single-pole selector used instead. The line by-pass condenser, C11, is connected to the chassis at this point to help prevent the 115-volt A. C. from interfering with the other sections.

In operation the switch is turned first to the "adjust" position (between C3 and "off"), and left until illumination of the eye shows that the circuit is operating. The "adjust-eye" potentiometer, R2, is then



In front and rear views the bridge looks like an amplifier which, indeed, it is.



turned until the eye is almost closed. Now connect the unknown capacity across the test leads, and turn the selector to the range most likely to cover. If, for some reason, you have no indication at all of the value of the unknown, work down from the highest range. Potentiometer R1 is rocked until the eye closes again. There may be a slight time delay.

To calibrate the dial, you will need seven condensers of known value and very close tolerance. These should be of the following values, in microfarads: .001, .002, .003, .004, .02, .03, and .04. Paste a circle of

LIST OF PARTS

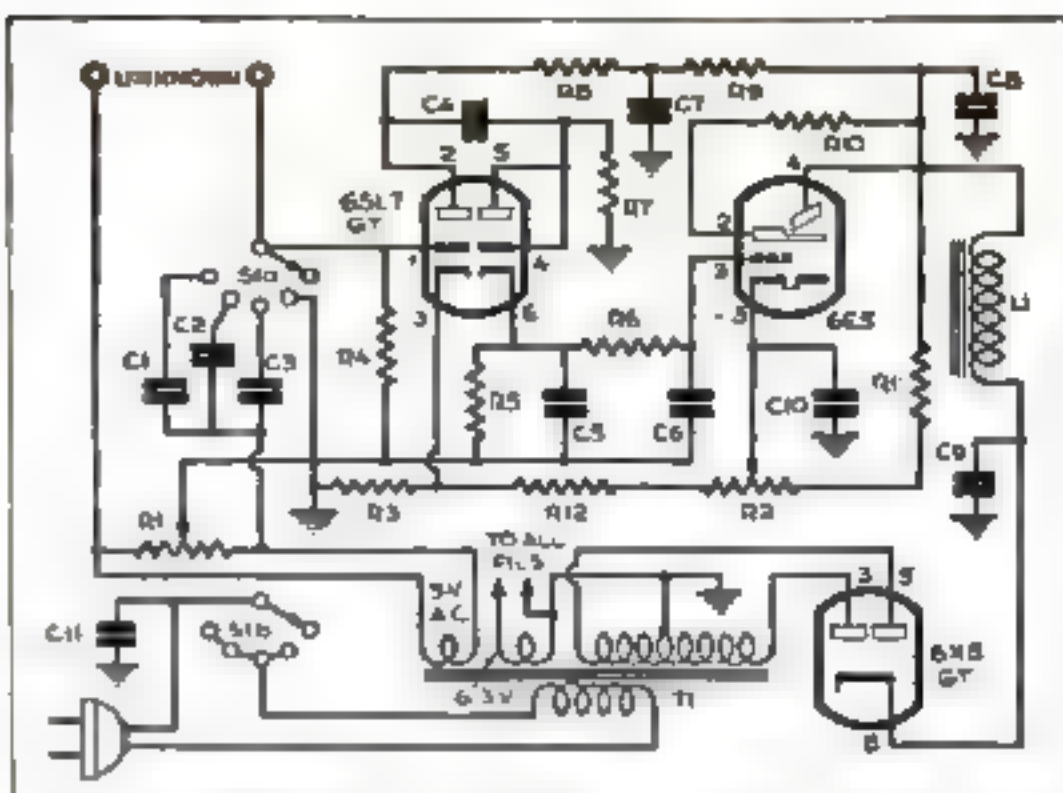
- R1: 400-ohm wire-wound linear potentiometer
 R2: 200-ohm wire-wound linear potentiometer
 R3, R12 32 ohms, close tolerance.
 R4: 10 meg
 R5, R7 1 meg
 R6, R8 500,000 ohms.
 R9 20,000 ohms.
 R10 2 meg. (in socket assembly).
 R11 10,000 ohms 10 watts.
 C1 1 mfd. close tolerance.
 C2: 01 mfd. close tolerance.
 C3 100 mmf close tolerance.
 C4: 1 mfd. 400 volts.
 C5, C6: .1 mfd. 400 volts (dual)
 C7, C8, C9 10 mfd. 350 volts electrolytic. (Triple-capacity unit, if available)
 C10 25 mfd. 25 volts
 C11 .05 to 1 mfd., 400 volts.
 L1: A. C. D. C.-type choke.
 T1: Small power transformer, 200 to 250 volts (at 30 ma.), 4.3. and 5 volts.
 S1a,b: Two-pole, five-position selector switch.
 Sockets, tubes, indicator-eye assembly

paper over the dial, and set the switch to the middle range. Starting with .001 mfd., adjust the eye for the null, and mark the dial at each step. Other values are obtained by adding the smaller units in parallel. For example, .005 is composed of .001 and .004; and the sum of the first four values equals .01. By adding condensers in parallel, the dial may be calibrated from .001 mfd. to .1 mfd.

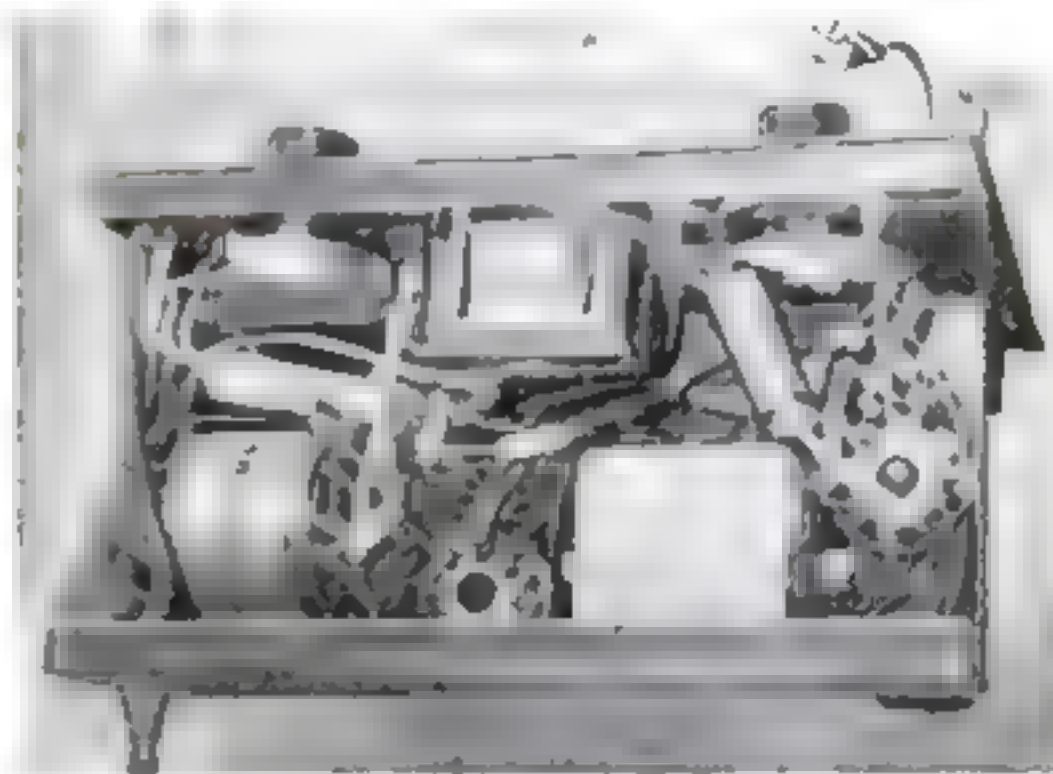
Since C1 is 100 times greater than C2, setting the range switch up to this point will multiply the scale by 100, and give readings from .1 mfd. to 10 mfd. At the other extreme, C3 effectively divides the calibrations by 100, covering the span from 10 mmf. to .001 mfd.

Electrolytic capacitors can be measured by the bridge since 5 volts of A.C. is not enough to damage them. The average electrolytic has some inherent resistance and inductance which tend to decrease the eye angle, but the true value will be indicated at the null despite the fact that the eye may not be completely closed.

This incomplete eye closure, by the way, may be taken as an index of the condenser's quality. Balance any good condenser, then connect, say, a 50,000-ohm resistor across it. Note that the eye will open slightly. The effect is equivalent to measuring a condenser with an internal leakage of 50,000 ohms. Connecting the resistor in series also



This circuit is an expanded version of Fig. 3 on page 190. Balance is obtained when the voltage division across the known and unknown condensers equals that across R1.



widens the eye, being comparable to the internal resistance of an electrolytic.

The values given assume a total high voltage of 200 volts D. C. across C8. If this voltage is incorrect, R11 may be replaced by an adjustable power resistor of about 15,000 ohms. This will permit adjustment of the total voltage across the divider so that the eye angle may be set properly with potentiometer R2. Approximately 1.5 to 2 volts maximum is required at the cathode of the amplifier section of the 6SL7.

Test clips were used instead of insulated binding posts since this offered an easy way of connecting unknown condensers.

If a complete indicator-eye assembly cable is available, use it by all means. And don't bother changing the internally connected resistor, R10; it will be correct.

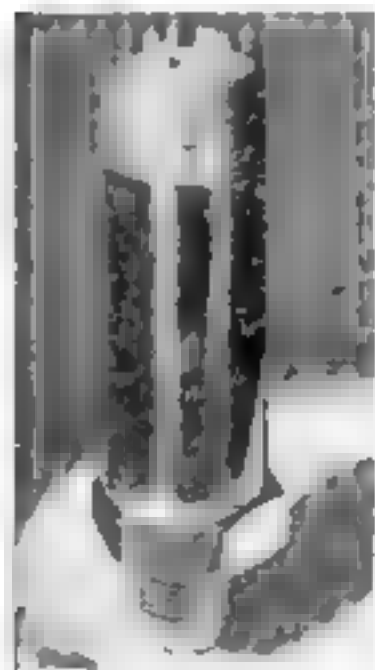


HOME-RECORDING instruments have been getting more popular and less expensive through the years. Latest in the new line of magnetic recorders (which now include wire and metal-tape devices) is the one using coated paper tape shown above. This model is a product of the Brush Development Company, of Cleveland.

PRESSURE IS TRANSLATED into electric current through this ingenious device designed by the Baldwin Locomotive Works. Utilizing the principle that the electrical

characteristics of a wire filament change with physical strain, this instrument transmits applied pressure in such a way as to stretch a current-carrying filament. The accompanying change in resistance can be made to actuate various controlling or recording systems.

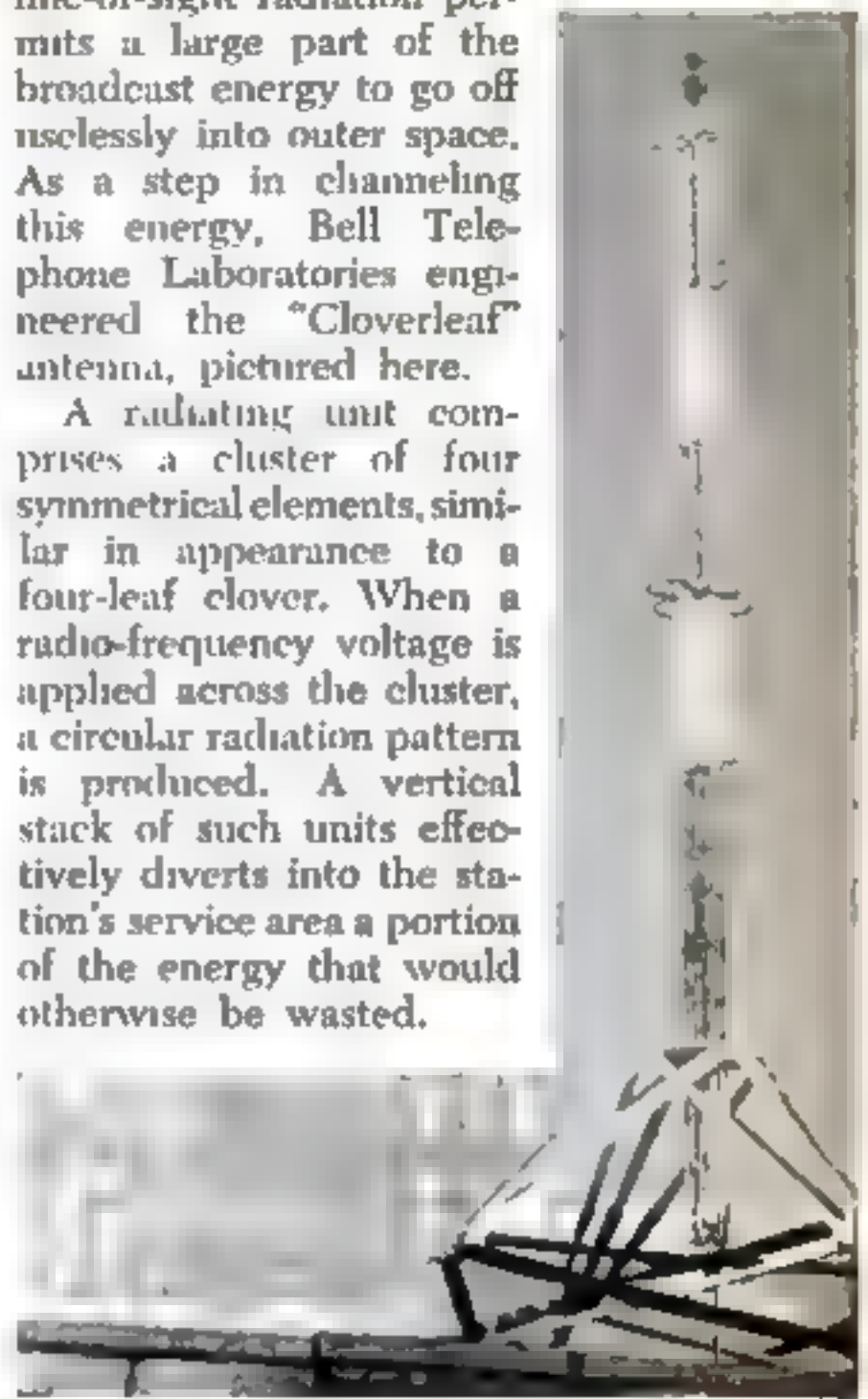
The instrument is known as the SR-4 Pressure Sensitive Device.



PORTABLE AMPLIFIERS, which made great strides during the war years, fit neatly into the peacetime scheme. Director Victor Saville, of M-G-M, carries a public-address system around with him and uses it to address large groups on outdoor location. The outfit is about the size and shape of an ordinary make-up box.

CONSERVATION OF ENERGY has become particularly important in the higher frequency radio services, such as F.M., where line-of-sight radiation permits a large part of the broadcast energy to go off uselessly into outer space. As a step in channeling this energy, Bell Telephone Laboratories engineered the "Cloverleaf" antenna, pictured here.

A radiating unit comprises a cluster of four symmetrical elements, similar in appearance to a four-leaf clover. When a radio-frequency voltage is applied across the cluster, a circular radiation pattern is produced. A vertical stack of such units effectively diverts into the station's service area a portion of the energy that would otherwise be wasted.



HOME EXPERIMENTS DRY ICE SHOWS



CAUTION

Wear thick gloves or use tongs in handling dry ice. Severe "burns" will result if your bare fingers come into contact with the ice or anything frozen with it. Never confine dry ice in a bottle or other closed container, for its vapor pressure will break any ordinary container.

SUSPEND A SHEET OF THICK LEAD by a cord and tap it with a pencil. You will hear only a dull thud. Immerse the lead in a dry ice mixture, made as described at the right, and tap it again. Immediately after removal from the mixture, the lead will ring like a bell. As the lead warms up, keep tapping it with the pencil and you will observe that the tone gradually returns to its original dullness.

PENCILS WON'T WRITE if they are too cold, as this experiment will demonstrate. An ordinary graphite pencil marks paper at normal temperatures because some of the graphite mixture rubs off readily. But freeze a pencil in the dry ice mixture, and see the difference. At best, you will get only a faint mark, and possibly none. The experiment must be done quickly, for the graphite warms up in a short time. Freezing seems to bind the molecules more tightly together.

MERCURY IS A METAL, although most persons think of it only as a liquid. You can solidify it with your dry ice mixture. Place a match-box drawer in a tumbler, fill the drawer with mercury, pour the freezing mixture over it, and quickly thrust a pencil into the mercury. Remove the mercury after a brief time and you can use it as a hammer. Then put it quickly into a glass, for it soon melts. (If you use a drinking glass, clean it to avoid mercury poisoning.)



EFFECTS OF EXTREME COLD



RESISTANCE DECREASES when metallic conductors are cooled, and electricity flows with greater ease. You can show this by making a coil of several dozen turns of fine iron or nickel wire and connecting it in series with a flashlight bulb and two dry cells. The bulb lights dimly. But immerse the coil in your dry ice mixture, as above, and the flashlight bulb immediately will light up brilliantly.



PLIABLE OBJECTS become brittle when they are subjected to great cold. You can observe this by standing the end of a hot dog in your freezing mixture and leaving it there for a few minutes. Then remove it and strike the frozen end with a hammer. The hot dog will break into fragments like stone. Rubber tubing, if frozen, will shatter in the same way. Allowed to thaw, any of these objects regain their original pliability.

WIRE SOLDER ordinarily is unelastic, but if subjected to great cold it will act like a steel spring. Coil a length of this solder around a small mailing tube and form a hook on each end. Then attach a cord to one hook and lower the solder into your dry-

ice freezing mixture. After several minutes, remove the coil and hang it up. It will retain its shape and bounce up and down when a weight is placed on the lower hook. But as it warms up, the spring gradually collapses and loses its elasticity, as below.



Big Coffee Pot Keeps Drinking Water Pure at Summer Cottage



WHEN drinking water must be carried from a well or spring at a summer cottage, a large coffee pot will make an ideal container. Leaves and twigs do not drop into it on the way and the lid keeps out dust. By hanging it on eyebolts as shown in the photos, the pot does not need to be taken down to pour water. Pry the eyebolts open to make hooks.—W. ALLPHIN.



Three-in-One Fisherman's Tool



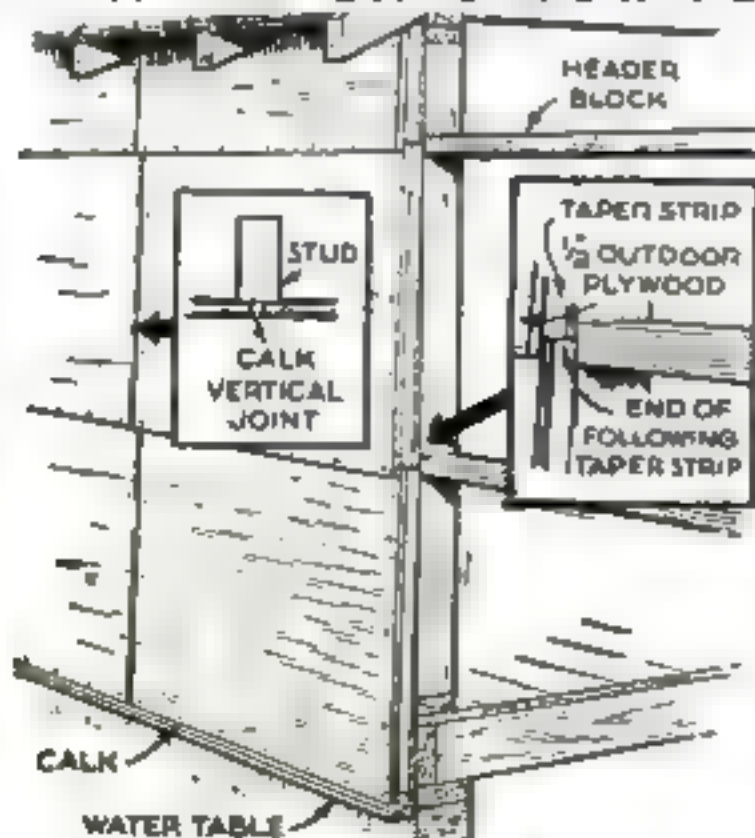
IF YOU file a small V-shaped notch in the center of the blade of a small pocket screwdriver, you will have a tool that can be employed in at least three ways on your fishing trips. It can be used as a real screwdriver, as a hook disgorger, and as a pick to help you untangle any backlashes that may snarl a line.—R. A. JENKINS.



Fly Ring Fitted to Casting Rod

A SMALL ring into which the fly can be hooked while you are carrying a rod can be made from a paper clip, as shown in the drawing above. Fasten the ring just above the rod grip by winding it with silk to match the winding on the guides.—R. A. J.

LAPPED EXTERIOR PLYWOOD [WOODWORKING]

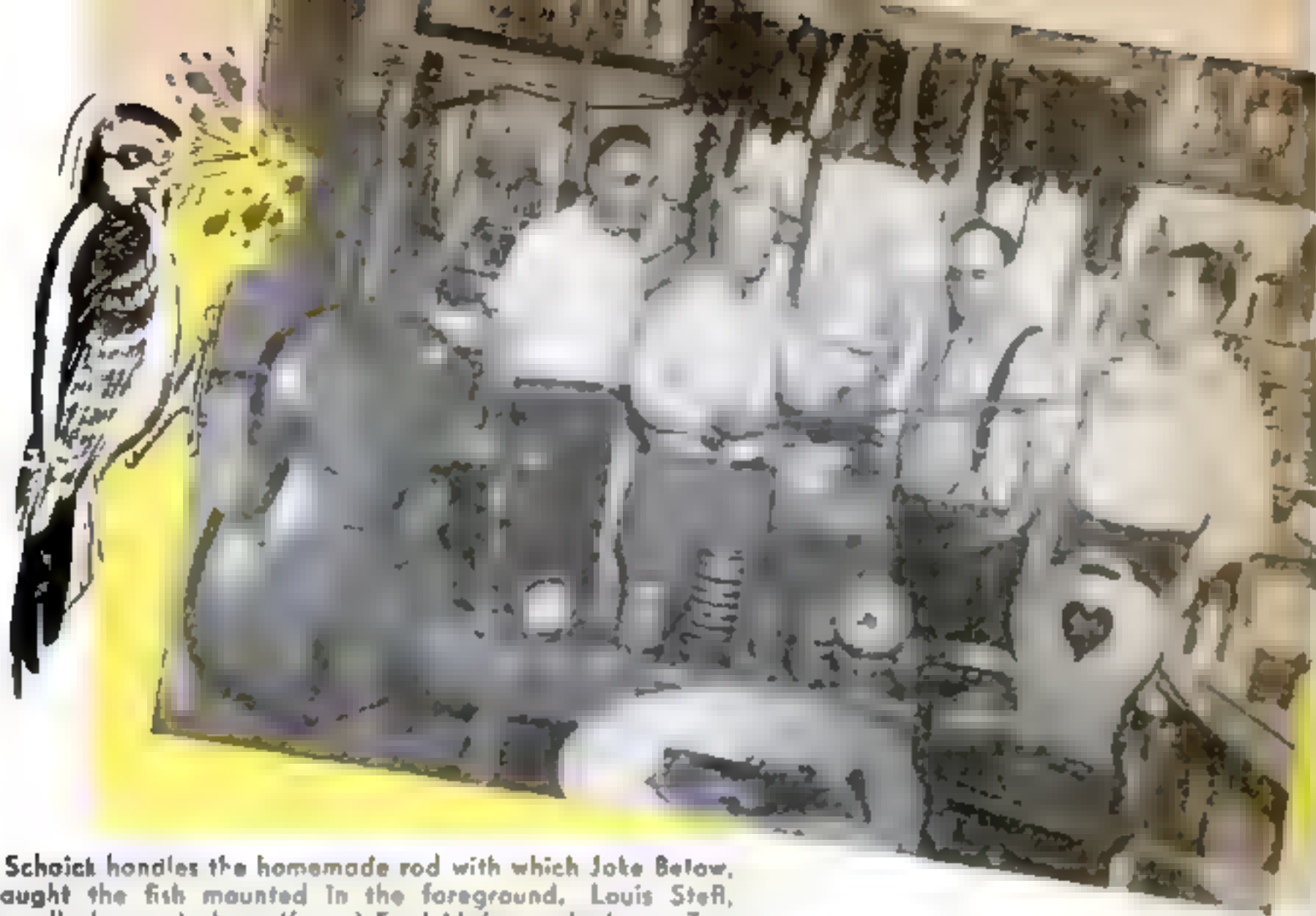


Application of $\frac{1}{2}$ " sheets of exterior plywood to studding with butted vertical joints and lapped horizontal joints provides a simple and inexpensive installation. Cut header blocks between the studs for horizontal nailing and nail wedge strips tapering up to $\frac{1}{4}$ " in thickness to the studs as backing for vertical nailing. Place a water table under the lower edge to turn water runoff from the foundation.

Seal the edges of the sheets with white lead or similar material. Some manufacturers recommend a coat of resin sealer on both faces of the plywood as well. A gap of $\frac{1}{4}$ " between butted vertical edges to be filled with mastic knifed in, is required, but the outside gap can be decreased by beveling the edges toward the back, forming a dovetail pocket that imprisons the caulking compound. It is important to use a thick line of mastic to preserve a soft inside core, preventing material shrinkage.

Use hot zinc-dipped or common or coated nails, set and puttied. Standard three-coat paint finishes are suitable as are textured finishes of resin-base joint with silox and asbestos.

POPULAR SCIENCE MONTHLY SHOP DATA



Dr. Van Schaick handles the homemade rod with which Joke Below, right, caught the fish mounted in the foreground. Louis Steff, beside a cello he made himself, and Fred Hofmann look on. Ties hung on the wall were taken from members to enforce a club ban.

Necktieless Workshop Club Is Retreat for Village Craftsmen

SOME years ago, when making jigsaw puzzles at home began to be popular, Dr. Roy Van Schaick, of Marion, Wis., got his first power tool. It was a jigsaw, a gift from Mrs. Van Schaick, who thought he would enjoy making puzzles from photos taken on his numerous fishing trips.

Then came Christmases and birthdays, each with a new woodworking power tool, and the room above the Van Schaick garage took on the aspect of a well-equipped home workshop. Out of these machines grew the idea for the Woodpecker Club.

There is no exclusive membership. Any man in Marion can belong, and most of them do—merchant, garageman, rural-mail carrier, policeman, baker—anyone who likes to fish and to make things out of wood. There is only one formality—no one can enter the club wearing a necktie. When someone does, the offending tie is confiscated. This rule is enforced, as attested by a hundred ties on display.

Regular meetings include a "feed," often with a prize fish as the main course, enlivened with music and stories. The club, the doctor feels, helps keep the villagers well with fewer fees for medical care. But he is philosophical—and, besides, he's having fun along with his cronies.

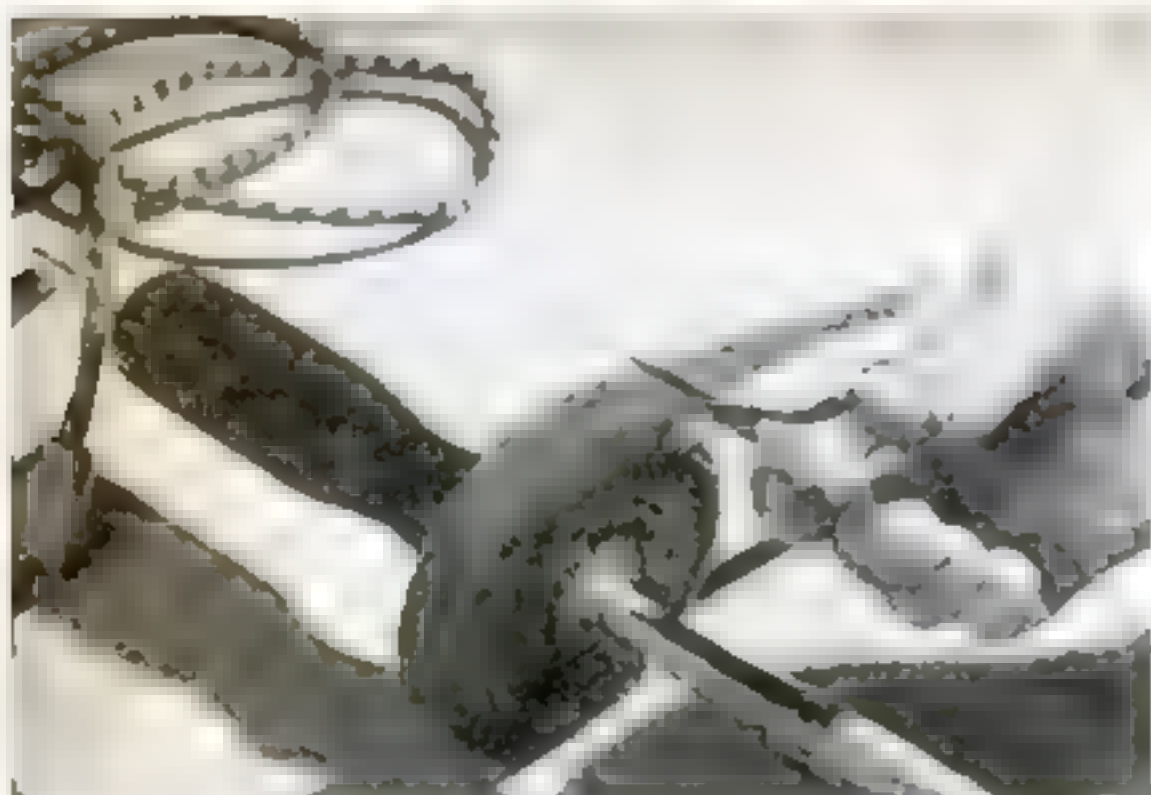


Hofmann and Vic Seyler find relaxation in pecking away after hours at favorite woodworking projects.

More than a dozen efficient power tools are kept in use in the club over Dr. Van Schaick's garage.



Weatherstrip Wrapped on Soldering Iron Protects the Hand



FELT weatherstrip wrapped around the handle of a soldering iron as shown at the left will serve as a shield to protect the hand from heat and from spattering of flux and solder, particularly when the iron is being used upward. The coil will retain its shape longer if several nails are inserted into the edge. Wrap the stripping as tightly as possible before placing the nails. Weatherstrip also can be used to wrap handles of all kinds that are likely to become hot and burn the hands.—KEN MURRAY.

Paper Clips Serve as Contacts



A PAPER clip makes a satisfactory substitute for a Fahnestock clip if bent as shown in the drawing and then soldered to a wire or mounted with a

screw to serve as a binding post. Small long-nose pliers are best for bending the clip. From the drawing, you will see that most of the bending is done on the long outer loop. The shorter loop must have sufficient spring action to keep the connecting wire in firm contact.—DICK HILL.

LOOSE-LEAF RING



Loose-Leaf Ring Holds Wire

LOOSE-LEAF rings of the type that snap shut can be used to hold together coils of electric wire, as illustrated above. This prevents the wire from becoming tangled, and the ring is easily removed when the wire is to be used. Two rings on each coil would be even better.—FRANK SHORE.

Truck Built of Scrap Iron Keeps Welding Equipment Handy

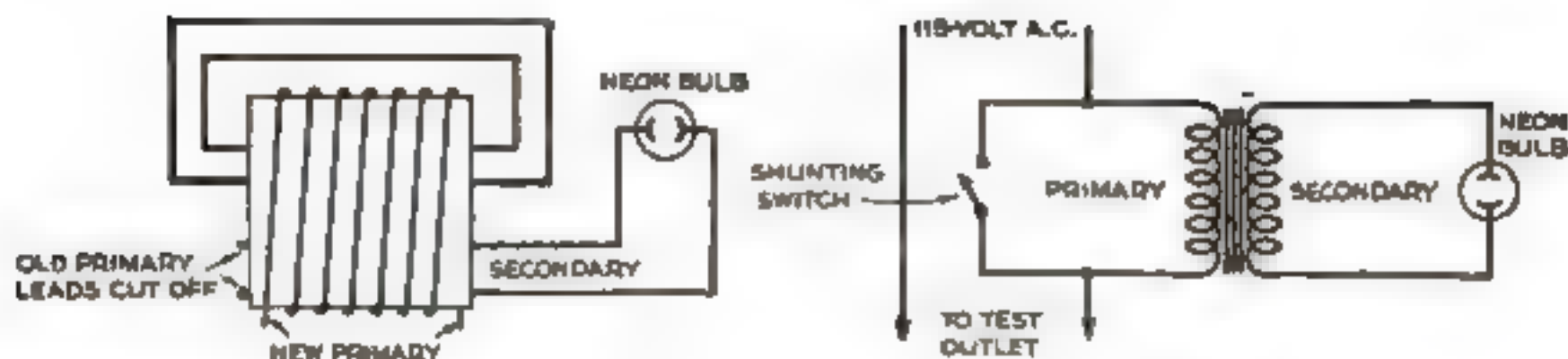


Fully equipped, it's ready for any job.

MOUNTED on casters, this truck makes it possible to have on hand everything needed for an arc-welding job anywhere in the shop. Angle iron was used for the frame, and sheet metal for the floor, top tray, and drawer. Two electric grinders are suspended from hooks on two of the uprights, welding rods of different size are stored in tubing cut from a truck drive shaft, and cables are wound on a drop-center car wheel welded to the truck.—E. S. HARRIS.



Cable is kept on car wheel.

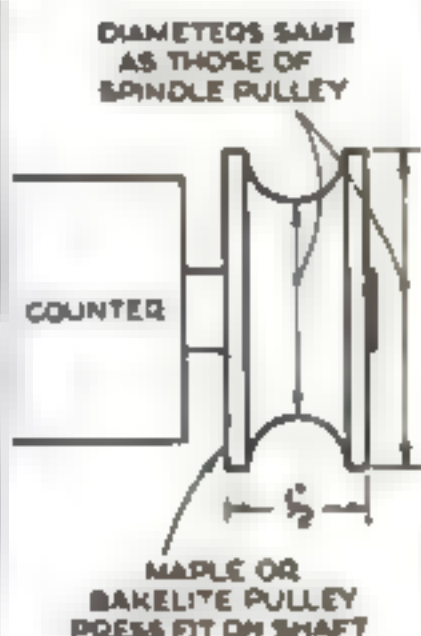


Neon Bulb Checks Automatic Control of Home Appliances

WANT to know when a thermostatic control cuts in an electric heating appliance? I've used this method on equipment ranging from 75 to 1,000 watts. Remove the case of an old audio transformer, make sure the primary is open, and wind over it 10 turns

of No. 14 D.C.C. wire. Connect the secondary to a $\frac{1}{8}$ -watt neon bulb. With the 10-turn primary in series with the test outlet or appliance line, the bulb will glow as long as the thermostatic control closes the circuit. A switch cuts out the device.—G. A. GAULD.

Turn Counter Adapted for Coil Winding in the Lathe



SIMULTANEOUS coil winding and turn counting can be done in the lathe with the aid of a small counter belted in some known ratio to the spindle. The counter is attached to a small right-angle bracket bent from $\frac{1}{2}$ " steel and mounted with machine screws on the side of the lathe bed. Pulleys on the lathe spindle and the counter shaft are of exactly the same diameter in the setup shown, but may be proportioned to suit the counter as necessary.

If the lathe spindle has a hub, a groove can be filed in it to fit the belt, and the diameter then taken with calipers. The pulley for the counter may be turned to match from maple or other hardwood. If

the lathe spindle has no hub, a wooden pulley might be sandwiched between the spindle flange and chuck, or a special coil-holding arbor turned with an integral pulley.

Accuracy should be tested by setting the counter at 0 and making one complete turn of the lathe spindle by hand. If the counter then registers less than 1, the counter pulley needs dressing down; if it goes beyond 1, the other is large. Make checks also for 10 and 50 turns.

A lathe that has no back gears for very low speeds may be run for winding by a small series universal motor and a resistance foot control. Use the original motor as a countershaft.—HAROLD P. STRAND.



REPAIRING CONCRETE WALKS and DRIVES

By CHARLES KIMBALL

PROPERLY mixed, finished and cured, the concrete in walks and drives should outlast even the buildings they serve—provided the concrete rests on a firm, well-drained footing. When deterioration sets in after only a few years of service, you can be sure one of these conditions has been neglected. And you can be equally sure if remedial measures are not taken in time, a complete new job plus the cost of breaking up and disposing of the old concrete will become inevitable.

Inspect the concrete after a heavy rain to see that water does not collect in pools and that the foundation is not waterlogged when the slabs are dry on top. Drain, if necessary, by revising the grade or by trenching and laying tile.

When water collects or hairline cracks widen so it gets through and turns foundation soil to mud, erosion will occur and the concrete will break away and sink—very quickly in a driveway, where the weight of a car will squeeze out the mud. Gravelly soil and foundation courses of cinders and crushed rock resist erosion, but in freezing weather trapped rainwater will expand the foundation. This raises the slabs, cracks them apart, grinds the edges, and widens contraction joints, those fine transverse cracks that develop at the grooves scored by the finisher.

Seal the slabs in dry weather with an asphalt such as roofing pitch or a prepared variety known as "roof putty" or "plastic roof cement." Pitch will fill the spaces with little shrinkage but it may chip in cold weather and it is gummy in hot weather.



and may stick to shoes if the seams are not below surface level.

Prepared mixtures can be used in summer just as they come from the package, or in winter they can be softened by heating in a hot-water bath. Usually a second application is required after a year to take up shrinkage, but the surface dries hard in a short time, the inside remains elastic for years, and because of a short-fiber asbestos binder, chipping is unlikely even when the inside hardens.

Clean out cracks with an old screwdriver and wire brush; then prime them with asphalt roof paint about the consistency of house paint. A satisfactory substitute for roof paint can be made by thinning plastic asphalt with dry-cleaning fluid or mineral spirits such as printer's thinner. If the paint is put in with a caulking gun, it won't mark up the surface. Rub it on the sides and bottom with a stick.

After the primer has dried for 48 hours, drive a peg at each end of the crack, bank dirt if necessary to keep the filler from nozing out, and pay in the asphalt level with the surface. A caulking gun eliminates the tedious and messy job of knifing in plastic asphalt. Pitch may be poured from a ladle made from a tin can as in Fig. 1.

In preparing pitch, break off fist-sized chunks with a hatchet and melt them until thin in a fairly heavy steel paint pail over a gas plate. Place the pail in a larger container to shield it from drafts, and ladle the

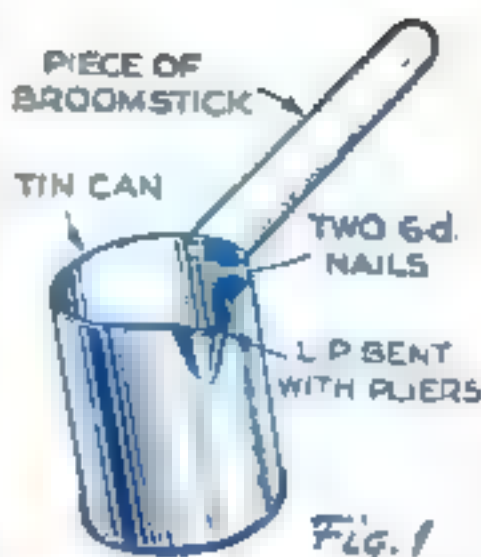


Fig. 1

pitch out on the job as needed. When it becomes sluggish, heat it again. Watch the heating carefully, for at over 650 deg. F. pitch may ignite and cause a dangerous fire.

Sprinkle sand over pitch seams to protect shoes. Spilled pitch can be stripped from a slab after hardening. Wipe plastic asphalt with a rag dipped in mineral spirits or cleaning solvent to remove spilled waste.

Cracks larger than hairline should be filled with sand or fine gravel tamped with the edge of a board until level with the bottom of the slab. If they won't admit a board, calk them with rags or hemp twine to within 2" of the surface before the asphalt is paid in.

Transverse expansion joints $\frac{1}{8}$ " wide every 40' or 50' and where the sidewalks and Drives cross (Fig. 2) prevent buckling in hot weather. If the filler has broken down or been omitted, apply the same asphalt used for sealing.

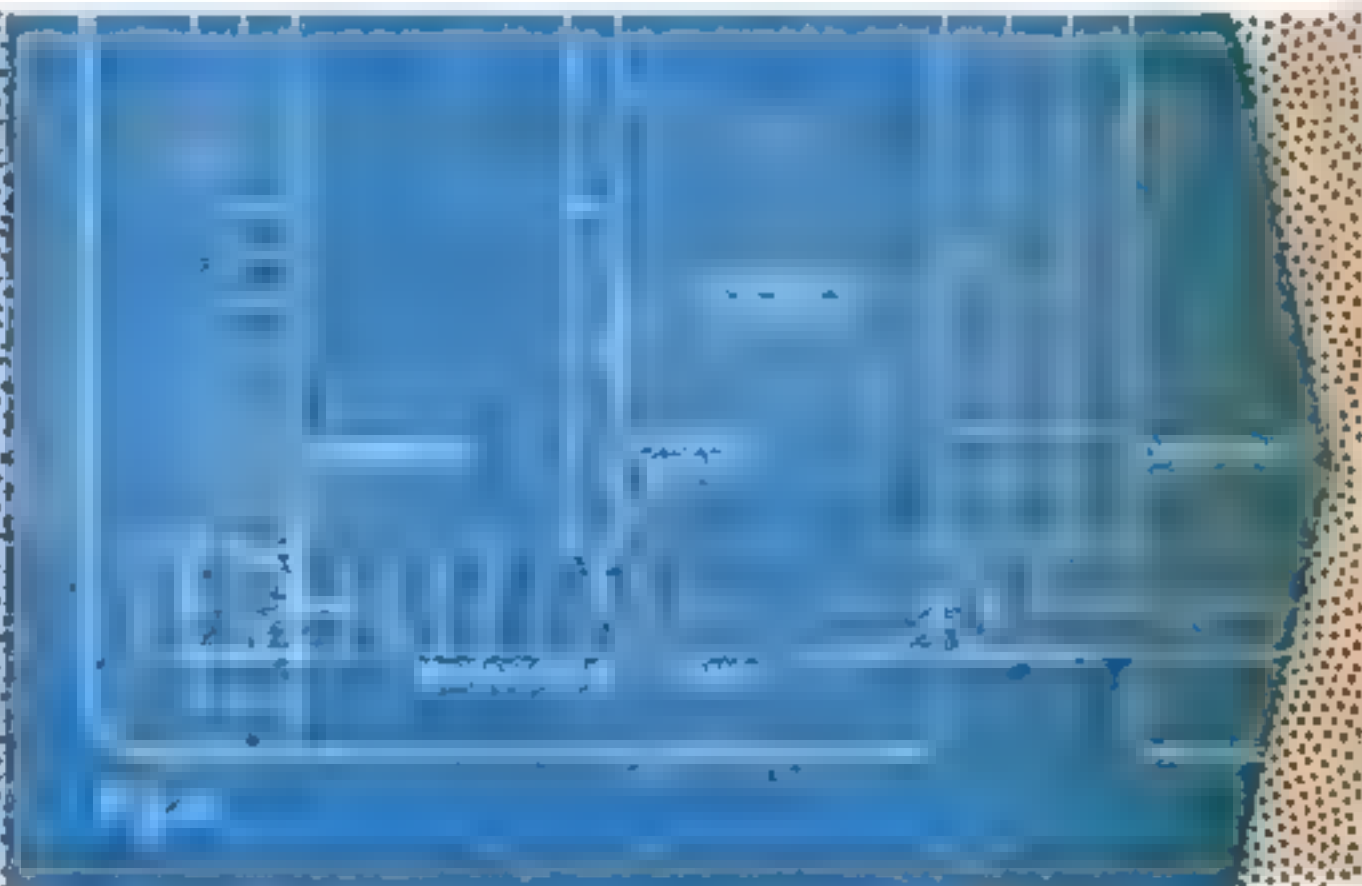
It is safest when new concrete is laid to call for expansion joints in the specifications and to see that they are put in. When a sidewalk does buckle, the usual repair is to cut off one or more slabs at the high point and relay them, chiseling enough off one for an expansion joint, or to pour new slabs, molding an expansion joint in one, as in Fig. 3. Pull out the stakes before the concrete sets; then after 24 hours lift out the wedge and fill the joint with asphalt.

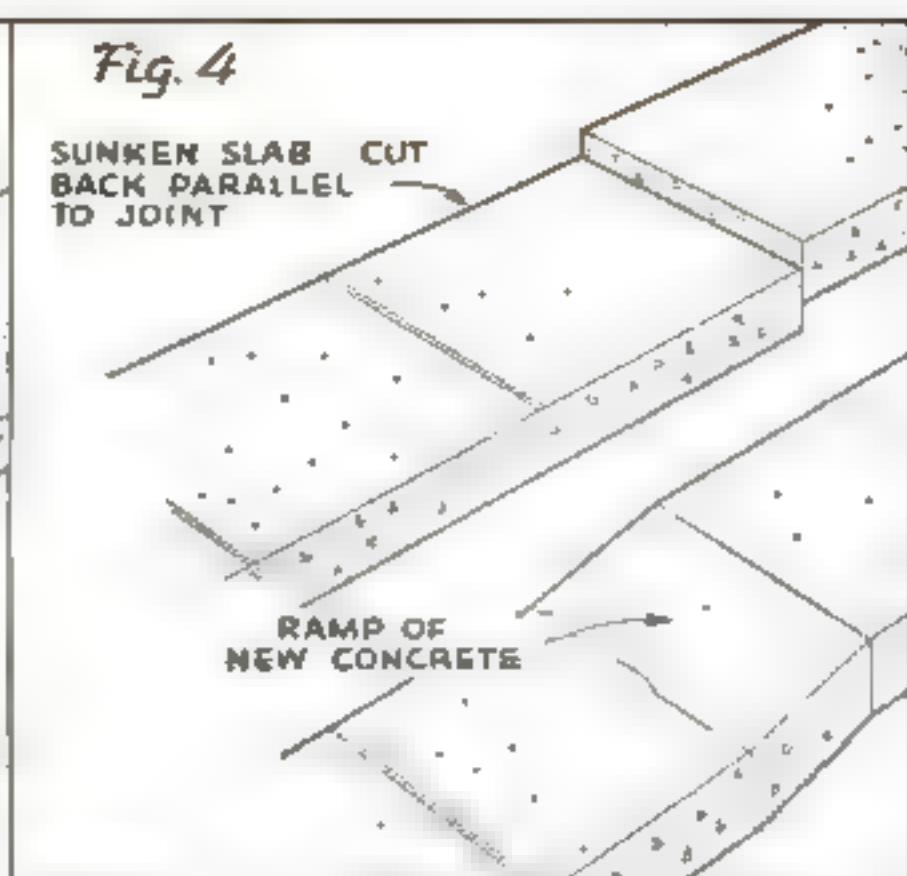
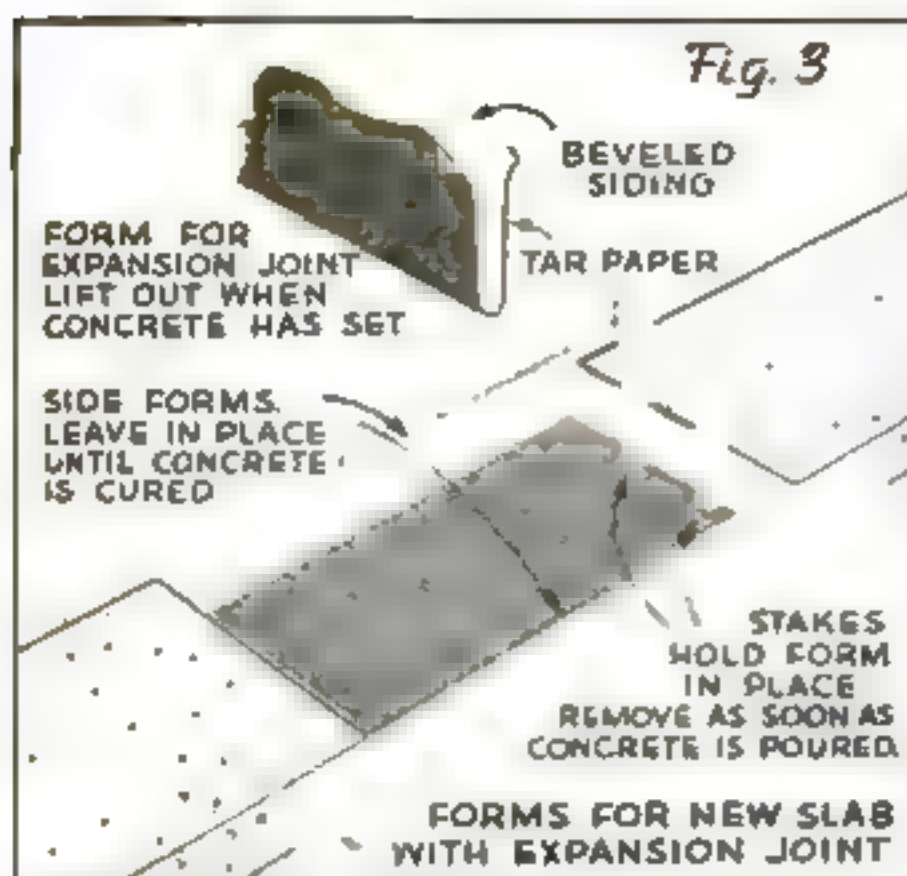
Caulking joints at the concrete foundation

Small batches of cement plaster are wet in a box, such as half of an oil can, and taken to the job, as at the far left.

Patches are troweled smooth on the surface, as shown at left center, and all excess plaster is removed with the trowel.

When a patch is at the edge or corner of a slab, a neat finish is obtained by edging the place with a pointing trowel.





of stoops and porches is also good practice. It waterproofs the foundation and prevents gradual widening of the joints by accumulated sand and dirt.

When a slab has sunk (Fig. 4), the high edge may be chipped off if the difference is slight, or the sunken slab may be lifted with a crowbar and relaid on a new filling of crushed rock. Heavy driveway slabs may be cut back 12" or so from the edge and the space between them filled with a concrete ramp, as also shown in Fig. 4. An expansion joint can be molded at the high edge if desired.

Occasionally grooves scored by the finisher are not deep enough, and the concrete cracks irregularly instead of in a transverse line. When the slabs are not too thick or too large to handle, cut off the jagged portions, as in Fig. 5, working a hammer and stonecutter's chisel lightly back and forth to deepen the groove. Gradually strike harder blows, especially near the ends, until the piece breaks off clean. Level the two trimmed slabs into position and fill-in with a square of new concrete.

If the slab to be squared has no groove, snap a chalk line across it and cut grooves about $\frac{1}{4}$ " deep with a V-edged chisel or the corner of a cold chisel. Then trim the piece square as before. Cutting by hand is practicable only for slabs up to 3 $\frac{1}{2}$ " thick. An air hammer is more accurate on thicker concrete.

Narrow longitudinal cracks may be filled with asphalt, wider ones with cement plaster except between building foundations or a foundation and curb. There, at least one

should be filled with asphalt to serve as an expansion joint.

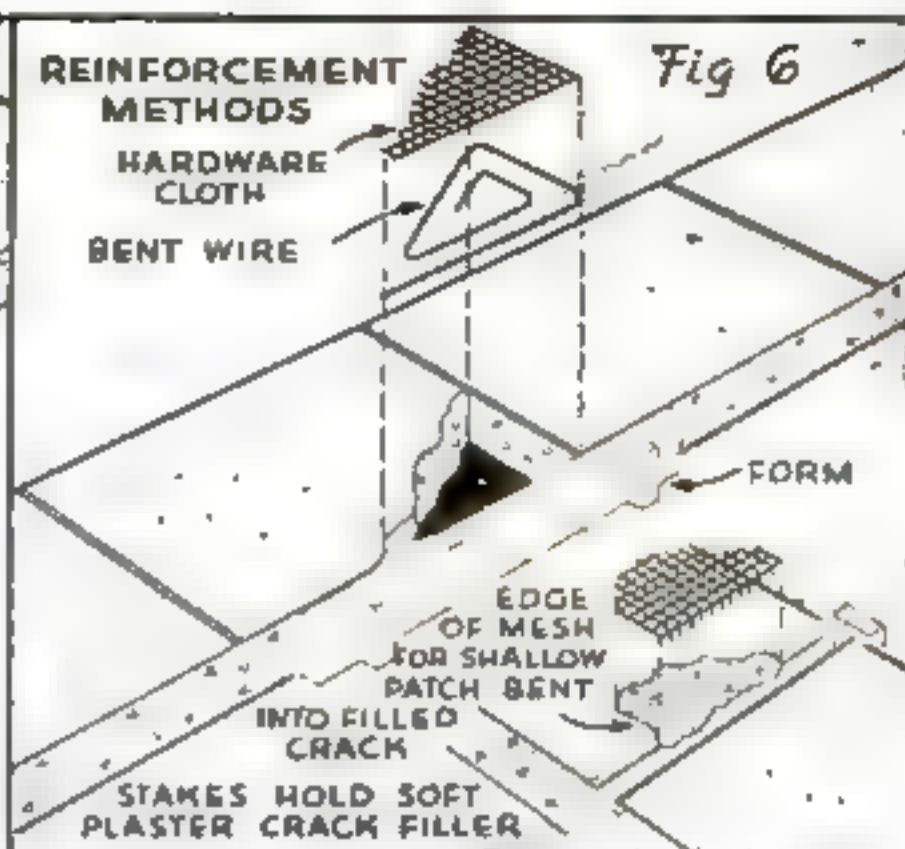
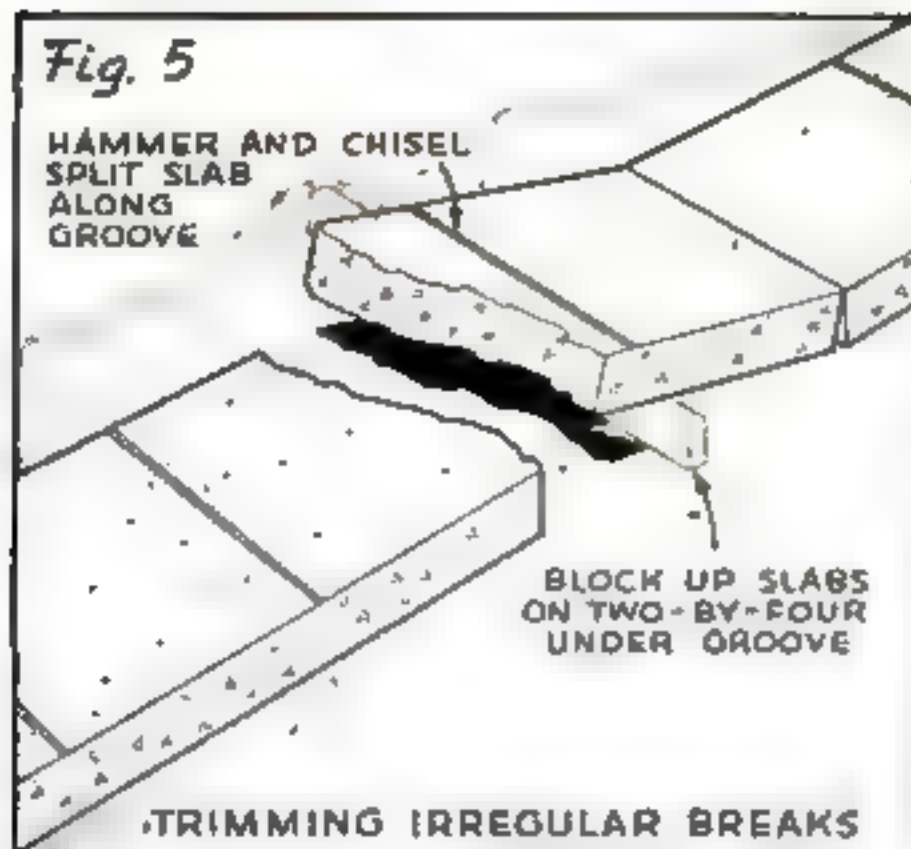
Cement plaster is made up of 1 part Portland cement to 2 parts clean sand. Adding hydrated lime up to 10 percent before putting in water will retard setting and make troweling smoother. Wet the mixture in small batches in a container such as a square-sided 5-gal. oil can split lengthwise. Crimped edges on such a container protect the hands against cuts.

Cracks wider than 1 $\frac{1}{2}$ " and holes and broken corners will need a plaster with 3 parts fairly fine crushed rock added. Concrete for an entire slab should be a standard 1-2-4 mix with $\frac{1}{2}$ " crushed rock.

Scrape, wire-brush, and tamp the place to be patched. Moisten the edges with a clean brush and sprinkle the tamped mate-

Firm, well-drained foundations are needed under concrete. Parts of this driveway subsided because of lack of a base of crushed stone or cinders.





rial until wet but not puddled. Fill a third of the way with plaster, tamp, drop in reinforcing wire, and tamp again. Then fill a third of the way higher, tamp and level, add a second reinforcing layer, and fill to the surface with plaster.

Strands of wire of correct length are used for reinforcing cracks, while bent wire and $\frac{3}{8}$ " hardware cloth or 1" chicken wire are used, as in Fig. 6, for large holes and broken corners. Have all reinforcing pieces cut and handy before wetting the plaster. Straighten them with pliers or a hammer, and if an end sticks out anyway, staple it down with bent wire. Divide long cracks into sections at the finisher's grooves. A board held with pegs serves as a form at a broken corner.

Tamp the top layer of patching concrete,

Sidewalks and driveways buckle in hot weather, as this walk did, if an expansion joint $\frac{1}{2}$ " wide is not provided every 40' or 50'.



trowel it smooth, and scrape off the excess flush with the surface. Finish by stroking with a wet brush. When 1-2-4 mix is used in a large hole, fill the top $\frac{1}{8}$ " with plaster containing no stone.

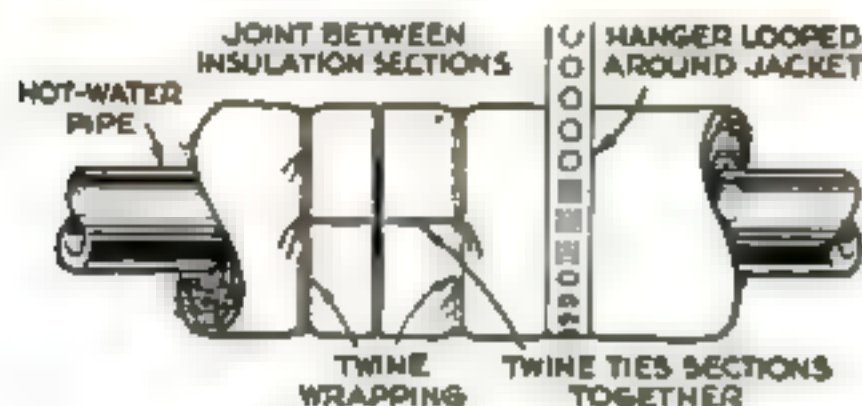
Where the topping of a two-course slab scales off in spots, the edges of the shallow holes must be chiseled back at a reverse bevel if patches are to be anchored. If a shallow hole adjoins a crack, a patch can be anchored with hardware cloth cut 1" or 2" wider than the hole and bent down at right angles, as in Fig. 6, into the plaster filling the crack. Or a $\frac{3}{8}$ " hole drilled 1" deep in the center with a concrete drill, or cut with a chisel, provides an anchor. Flare the hole at the bottom and drop in a couple of nails head down and point bent outward.

Use stiff plaster with little water for curb patches. Moisten the break, fasten in reinforcing wire, and press in and tamp the plaster, leaving a $\frac{3}{8}$ " recess. Add hardware cloth and trowel on thinner plaster.

Cure a patch by slowing down its drying with a coat of colorless sealer sold for the purpose by cement-supply dealers, or make your own sealer from 1 part by weight of melted paraffin and 6 $\frac{1}{2}$ parts of gasoline, painter's thinner, or cleaning solvent and brush it on while warm. Hose the surrounding concrete daily for a fortnight. Weighted tar paper wet down daily will serve as a substitute in a pinch.

Repairs may be walked on the next day, and cars may be driven over small patches after a full 24 hours. Protect a new slab for two or three days with planks extending to the old concrete.

Home Hot-Water Pipes Insulated with Rug Padding and Paper



INSULATION of hot water pipes that run from the heater to the kitchen and bathrooms is an economy measure that can be accomplished by the home craftsman with paper and the padding of the sort used under rugs. Old carpets, rags, commercial flexible insulation, or even a thick padding of newspapers might also be used.

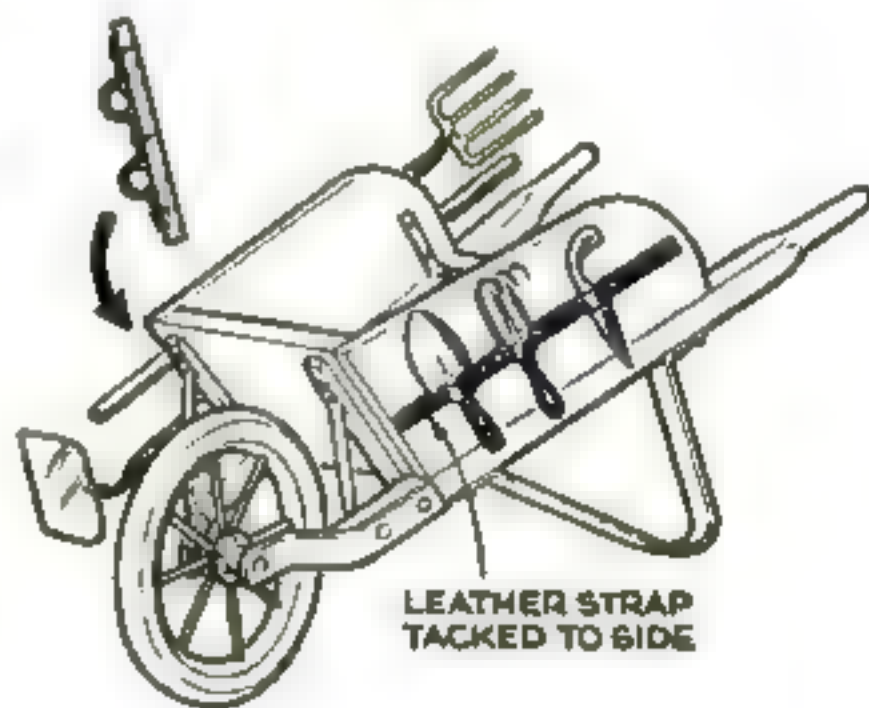
With carpet padding and wrapping paper, I insulated 65' of pipe in six hours' time. For $\frac{1}{2}$ " pipe, the padding should be cut in 12" by 24" strips. Larger pipe would require slightly wider pieces. In my installation, I cut wrapping paper in 24" squares and interwrapped it with the padding around the pipe, providing additional insulation and a cover for the fabric. The paper also makes tight wrapping easier and gives you a neat job.

Cellulose tape held the rolls temporarily while string was wrapped around them as permanent lashing. Each section was attached to the next with string, as shown in the drawing. Where pipe hangers interfered, they were removed and replaced after the pipe had been wrapped.—R. B. Lewis.

Kraft Paper Is Useful in Home

MOUNTED in a combination holder and cutter in a corner of the garage or cellar, a roll of kraft or white butcher paper will be useful to all members of the family for such purposes as wrapping packages, covering furniture or floors while cleaning or painting, making caps for garden plants, covering work tables, and as drawing paper for children.

Cutter racks and paper in a variety of widths can be obtained from paper supply houses at little cost. One roll should last for years.—R. B. L.



Rack Keeps Garden Tools Handy

If you find yourself making frequent trips back to the garage or tool house for needed tools while working in the yard or garden, a rack on the side of your wheelbarrow will save you many steps. Cut strips of leather from a discarded boot and tack them to the side of the wheelbarrow to form loops in which to place all the tools while they are not in use.—R. M. Woodbury.



Magnesium

the BANTAMWEIGHT METAL

How Chemists Have Put It to Work as a Jack-of-All-Trades.

By KENNETH M. SWEZEY

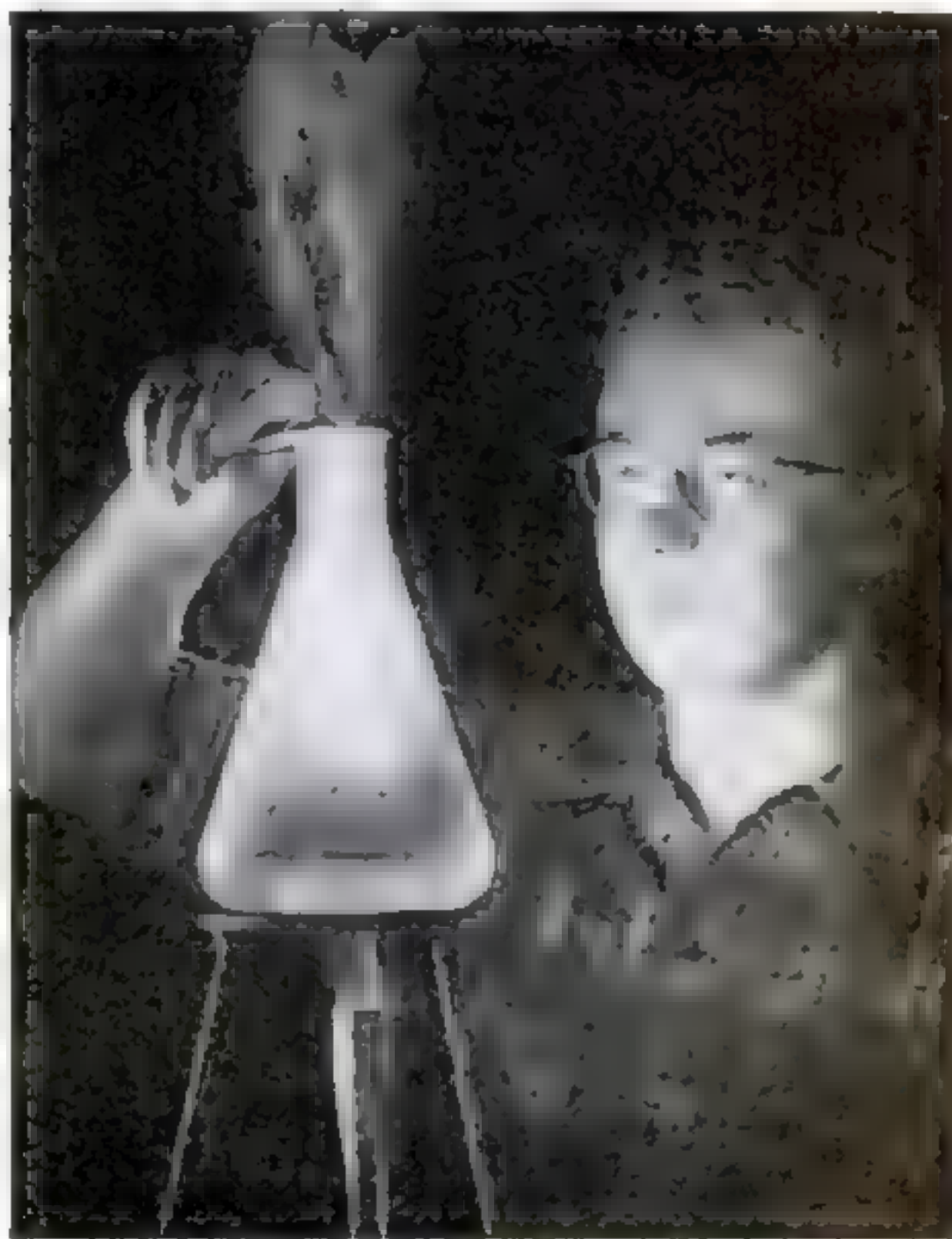
DURING the war magnesium was extensively used as a lightweight structural metal for aircraft parts and as pyrotechnic material for star shells, signal flares, tracer bullets, and flash and incendiary bombs. Strong, silvery white, and only two thirds as heavy as aluminum, it is the lightest of all construction metals. In the form of powder, thin sheets, or wire, it burns with a dazzling flame that water or even carbon dioxide will not put out.

Never found alone in nature, magnesium is made on a tremendous scale by the electrolysis of its compounds. These compounds are among the most plentiful substances in the crust of the earth. Whole mountain ranges consist of dolomite, a double carbonate of magnesium and calcium. Asbestos, talc, and meerschaum are magnesium silicates. Epsom salts, named after the springs at Epsom, England, where they were first isolated in 1695, are magnesium sulphate. In the form of its chloride, there are nearly 8,000,000 tons of magnesium in every cubic mile of the sea, a vast storehouse of supply.

Less spectacular, perhaps, than the metal, the compounds of magnesium are just as important. Asbestos and magnesium oxide are among our most valuable insulators against heat. Magnesium oxychloride forms a superior artificial stone and

flooring material. Magnesium carbonate is used for insulation and for making dentifrices, talcum powder, other magnesium chemicals, and Pyrex glass. Epsom salts, citrate of magnesia, and milk of magnesia are three of the many magnesium compounds that are employed in medicine.

With only a box of Epsom salts as a starting material, you can make many of these compounds in your home laboratory. With a few inches of magnesium ribbon,



Because of its capacity for stealing oxygen, magnesium burns brightly in steam, as above, or even in carbon dioxide. This property made it useful for incendiary bombs during the war.



When burning in carbon dioxide, as at left, magnesium metal decomposes this gas into oxygen and carbon. Nitrogen ordinarily is an inert gas, but burning magnesium will unite with it, as the center experiment will show. Mix water-clear solutions of lye and Epsom salts, as at right, and you have milk of magnesia.

you can likewise test some of the exciting properties of the metal itself.

One property that helps make the metal such an important incendiary material for wartime use is its ability to steal oxygen from such ordinarily stable compounds as water and carbon dioxide. During the war, magnesium fires generally were extinguished

by smothering with sand. Water helped only when applied in quantities sufficient to cool the metal below the point of combustion. This was rarely possible.

As a demonstration of magnesium as an oxygen grabber, boil some water in a flask, and then with tongs lower a short length of lighted magnesium ribbon into the steam.

(Put away the rest of the ribbon before lighting the piece, and always handle with caution.) Instead of going out, the magnesium continues to burn brightly, getting oxygen by decomposing the steam.

Carbon dioxide, usually one of the best fire-extinguishing materials, is as helpless as steam against burning magnesium. Fill a beaker with this gas by pouring $\frac{1}{2}$ " of water into it and adding a little baking soda (sodium bicarbonate) and vinegar or other common acid. As soon as the bubbling has stopped, test for carbon dioxide by lowering a lighted match into the beaker. The match will go out at once.

Now lower a piece of burning magnesium into the glass and see the difference. The metal continues to burn furiously. In the process, it changes into magnesium oxide, and black specks of carbon, wrested from the carbon dioxide gas, are flung to the sides and bottom of the beaker.

Hydrochloric acid and magnesium hydroxide form magnesium chloride, a sea-water compound that yields magnesium metal.





Magnesium oxychloride cement, a hard, durable material widely used for imitation stone and for flooring in office buildings, can be made as shown here. Dissolve all the magnesium chloride you can in water at room temperature, add enough magnesium oxide to make a paste, and pack it into a cardboard form.

Even nitrogen, which ordinarily is one of the most inert gases, will unite with hot magnesium when conditions are right, forming magnesium nitride. To show this, put a few short pieces of magnesium ribbon on the center of an upturned can cover and heat the cover over a gas flame until the metal catches fire. Then remove the cover from the flame and allow it to cool until you can touch it with your hand. Now put several drops of water on the warm substance that remains and hold a bit of cotton wool moistened with hydrochloric acid above it. White smoke of ammonium chloride immediately rises. On burning, the magnesium united with oxygen and nitrogen from the air, forming the oxide and nitride. When water was added, the nitride decomposed into ammonia gas and magnesium hydroxide.

Most magnesium compounds can be produced from the carbonate or the hydroxide. The carbonate occurs naturally as magnesite and, mixed with calcium carbonate, in certain forms of marble and limestone. It can be made artificially by mixing hot solutions of magnesium sulphate (Epsom salts) and sodium carbonate (washing soda). Since the carbonate

is not soluble in water, it is precipitated as a fine white powder. When dried, it can be used as a polishing agent and for heat insulation.

Magnesium hydroxide also is made by precipitation. Again you can start with your Epsom salts, this time adding a solution of sodium hydroxide (ordinary lye). When dis-

Hydrochloric acid can be produced by heating magnesium chloride crystals and allowing the gas to bubble through water, as below.



solved, both of these solids produce clear solutions. Mixed together, they form a white precipitate. A suspension of this, in pure form, is the drug-store "milk of magnesia."

By strongly heating either your hydroxide or carbonate, you produce magnesium oxide (magnesia), used widely for heat insulating, for the lining of high-temperature furnaces, and for making oxychloride cement, widely used for flooring and imitative stone.

By dissolving either the carbonate or hydroxide in hydrochloric acid you get magnesium chloride, the compound found in sea water from which magnesium metal is made in vast quantities. To obtain crystals of this chemical, evaporate the solution over a water bath until nearly dry. Then complete the drying in a warm dry place in the open air.

If the heating is continued too long, the crystals will lose some of their water content and partly decompose, giving up hydrochloric acid.

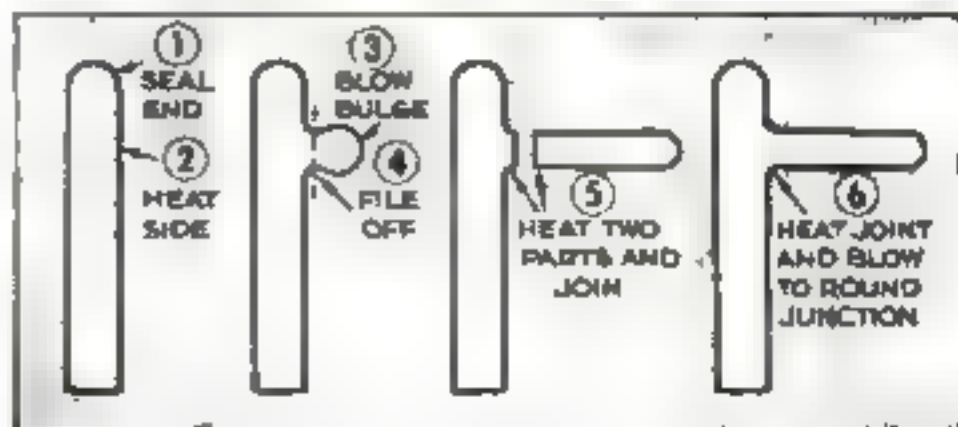
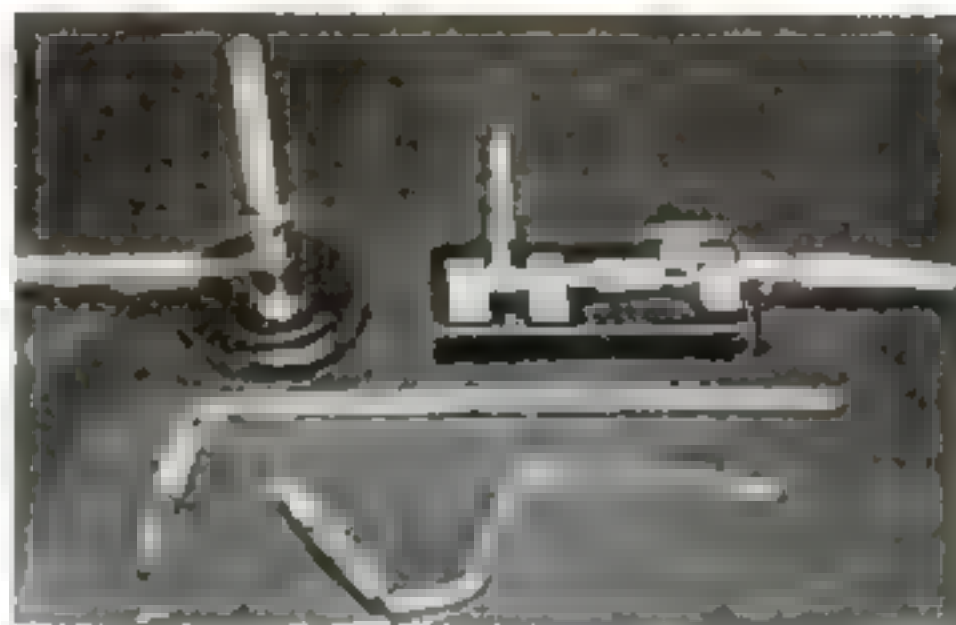
This decomposition of magnesium chloride by heat provides one method for the manufacture of hydrochloric acid. As a demonstration, put some crystals of magnesium chloride in a test tube and fit the tube with a stopper having a glass delivery tube long enough to reach the bottom of a second test tube, which is half filled with water. Now gently heat the crystals. They will first melt, and then vapors will go through the delivery tube and bubble up through the water. Part will be water vapor and part hydrogen chloride. The latter will dissolve in the water, changing it into hydrochloric acid.

Versatile Microburner Furnishes Heat for Numerous Lab Jobs

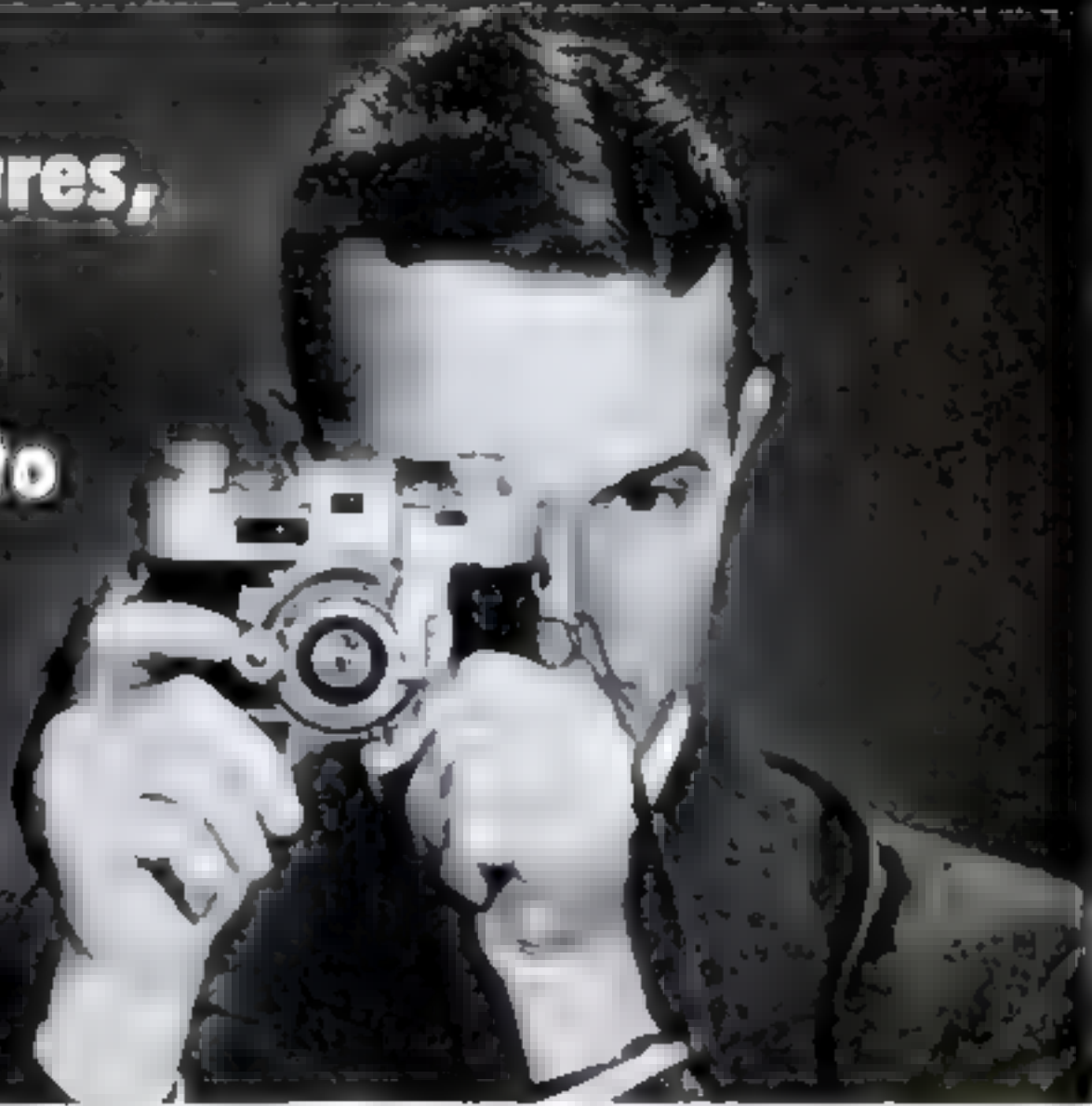
INSTANT adjustment of the flame and easy interchange of nozzles are features of this microburner. If nozzles with openings ranging from .1 to .5 mm. are provided, the burner will serve for virtually any laboratory job where a narrow hot flame is needed. Such nozzles can be made by heating a piece of tubing in the center, stretching it out and filing off at the narrow part, and rotating the tip in a flame until only a tiny opening remains.

For the burner T-joint, select an 8" piece of tubing with a diameter that fits snugly over a stopcock tube. Heat and seal the tubing at one end, (1); then heat the side 1" from that end, (2); blow a small bulb, (3); and cut this off with a file, (4). Seal one end of another tube about 3" long, heat the other end and the rim remaining from the bulb, press them quickly together, (5), and pull out slightly. Heat the joint and blow into the tube to force the glass to a smooth rounded junction, (6). Then anneal in a yellow flame. Cut off the side tube 1" from the joint and the main tube 2" from the joint. Fire-polish the ends.

Assemble the parts with rubber tubing as in the lower photo. The entire unit then may be mounted on a 2" by 5" wooden base, as in the top photo. In this photo also are seen two easily-made glass blowpipes that you may find useful in your lab.—A. C. NUSSLE.



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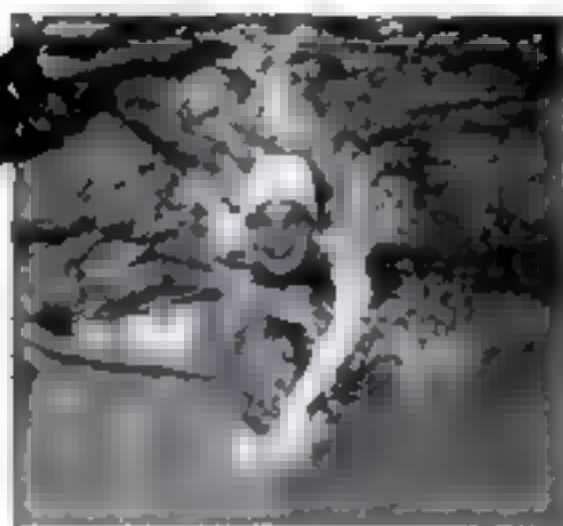


Above: KODAK 35 (f/3.5 with range finder), a precision-built 35mm. camera well worth waiting for.



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CHEMICALS



For extra emulsion speed, fine grain, general high quality—Kodak Plus-X, the all-round "pan" film. Rolls and packs.



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Kodak's new UNIVERSAL M-Q DEVELOPER, in the handiest "chemical package" yet—only 5 cents. Two metal foil envelopes, clipped together in a match-book-style folder. Contents make solution sufficient to process 3 rolls of 620 film, 12 sheets of 5x7 film, or 72 sheets of 2½x3½ paper.

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For best enlargements from any negative, with any enlarger—KODABROMIDE, all-purpose enlarging paper. Rich blacks, clean whites, delicate gradations. Five contrast grades. Wide latitude. At your Kodak dealer's . . . Eastman Kodak Co., Rochester 4, N. Y.



Kodak

"PLINK"... or... "PLUNK"?



HERE's one of the many tests or inspections Nicholson and Black Diamond files go through before they're permitted to face the world under the guarantee of *Twelve perfect files in every dozen.*

It's the "ringing" test for soundness. The inspector taps the file on a metal block. If its ring is a clear "plink," the verdict is "o.k." If a dull "plunk," most likely there's an invisible "water crack" somewhere, and the file is rejected.

Every Nicholson and Black Diamond file is given the "ringing" test. In fact, every important step in its manufacture is closely watched. As a result, these famous files come to you with unsurpassed uniformity—in shape, dimensions, cut, hardness and soundness. Good hardware and mill-supply houses sell them.

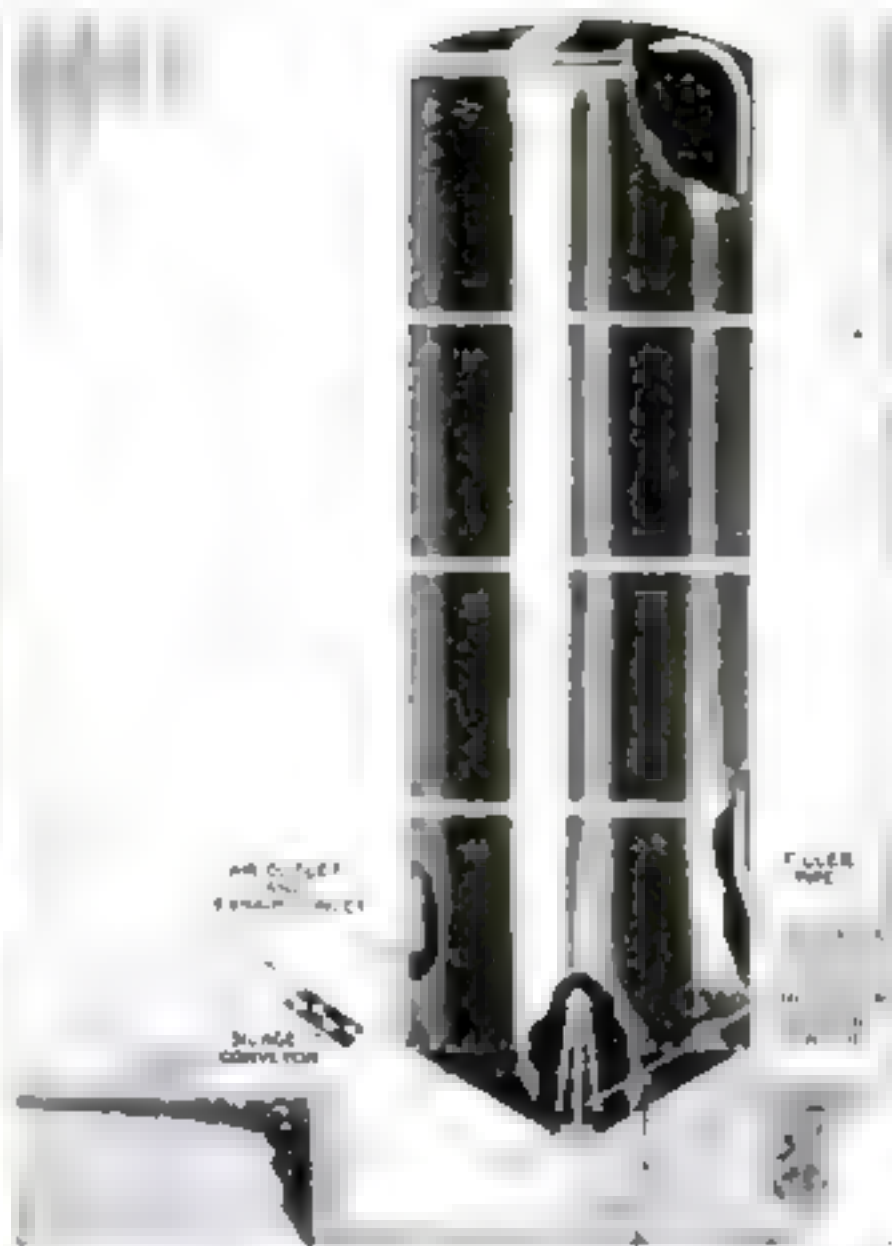
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FILES FOR EVERY PURPOSE

POPULAR
SCIENCE



Glass-Coated Steel Silo

AIRTIGHT because it is coated with glass both inside and outside, this experimental steel silo keeps its contents unspoiled much as food is preserved in glass jars. Engine-driven mechanism removes silage through a 24-inch hopper at bottom, and the engine feeds burned-out air into the top of the silo to keep out the oxygen on which molds thrive.

The silo, planned for commercial production in 1947 by the A. O. Smith Corp., of New York, is about one-sixth as heavy as a concrete one, while its estimated cost is comparable to that of a standard silo. Besides its other advantages, the glass coating eliminates the need for painting.

Ten glass-coated silos are being built for experimental use this year; some will store green hay.

Business Guidance for Vets

AS A GUIDE to discharged servicemen and in an effort to stimulate individual enterprise in all war veterans, The Reader's Digest recently published a manual of ideas for small businesses, called "A Business of Your Own." The project is strictly a nonprofit service. The booklets, which are now available, sell for 25 cents a copy.

Smooth HORSEPOWER



CASITE

**GUARANTEES BETTER AND SMOOTHER
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● Protect that new motor—get a new thrill out of that old motor—with Casite.

Casite carries oil quickly to the tight spots . . . protects new motors during break-in period . . . reduces engine wear . . . retards formation of sludge and gum . . . keeps motors clean and full of zip.

And everyone knows that a clean motor runs better and lasts longer.

Put a pint in the crankcase every oil change and a pint through the air intake every three months—for better and smoother performance all-year-round. Sold by service stations, car dealers and garages, everywhere.

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JULY
1946 211

Easy, boy — here's our Vacation!

Easy is right! This is no year to be careless with anything as precious as an Evinrude!

Whether it is a sparkling new '46 model — or a faithful old-timer — what really counts in vacation plans is the fact that it's an *Evinrude*! That means the assurance of satisfying performance wherever you go. It means rugged stamina and power you can bank on . . . finger touch handling ease and starting sureness *built right in*! It means a happier vacation, more fun on every trip.

Complete range of models . . . the right motor for every boat, every service. Light "singles" for smallest craft, powerful "twins" and four thrilling four-cylinder models. **See Your Evinrude Dealer!** Look for his name in your classified phone directory under "Outboard Motors". Catalog free — address EVINRUDE MOTORS, 9327 N. 27th St., Milwaukee 9, Wis.

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Gives features and specifications on all Evinrude models, and helpful information on boats, speeds, etc. It's free . . . write for it today.



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"I Always Have Luck with the JITTERBUG"

— writes girl angler

Dear Fred:

"I caught these seven good-sized bass and two pickerel within a few hours on your 'Old Faithful' Jitterbug at Burden Lake.

"I always have luck with the Jitterbug. We use them on all our fishing trips and wouldn't be without them. Some day I intend to try your other lures and I hope they are as good."—(Miss) Tina C. Boel, Red Mill Road, Rensselaer, New York.

Write for New Catalog

Gives you complete information on where and how record catches are being made with Jitterbugs, my famous surface bait, and also my family of Hawaiian Wigglers. A copy is yours for the asking.

Jitterbug and Tina Lure Bass!

Tina with bass and a couple of pickerel caught on the Jitterbug. Seems from her letter that Tina, like many male anglers, is quite sold on the wobbly, noisy Jitterbug as a fish-getter.

Choice of Six Colors

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WORKSHOP WISDOM

REWINDING FISH RODS



When rewinding your rod, add more guides to distribute strain of strike more evenly.

A coat of CASCAMITE, the highly water-resistant glue, will protect areas under windings from damp rot.

How to rewind your rod:

Remove old windings, guides, ferrules.

Next, rotten stone or pumice all surfaces free of old varnish and glue.

Spread a thin film of CASCAMITE on areas to be wound, and wind guides on tight with silk thread. Coat section ends and tip with CASCAMITE and cap with ferrules.

When dry, varnish both rod and windings.

CASCAMITE also mends cracks between bamboo splits.

Gives rod added resilience and "whip."

Why folks prefer CASCAMITE:

Easy to mix. Just add CASCAMITE to cold water and stir.

Strong. CASCAMITE glue joints are stronger than the wood itself.

Economical. Mix CASCAMITE as you need it. No waste.

Get CASCAMITE—and CASCO—the standard casein household repair glue, at your hardware store—in 10¢, 25¢, and larger sizes. For outdoor and boat work, use CASCOPHEN, the new, completely waterproof resortinol-resin glue.

WRITE FOR FREE GLUING GUIDE: Contains complete gluing directions plus helpful hints for household repairs. Address a post card to: Casein Company of America, Dept. PS-7a, 350 Madison Ave., New York 17, N. Y.

CASCAMITE

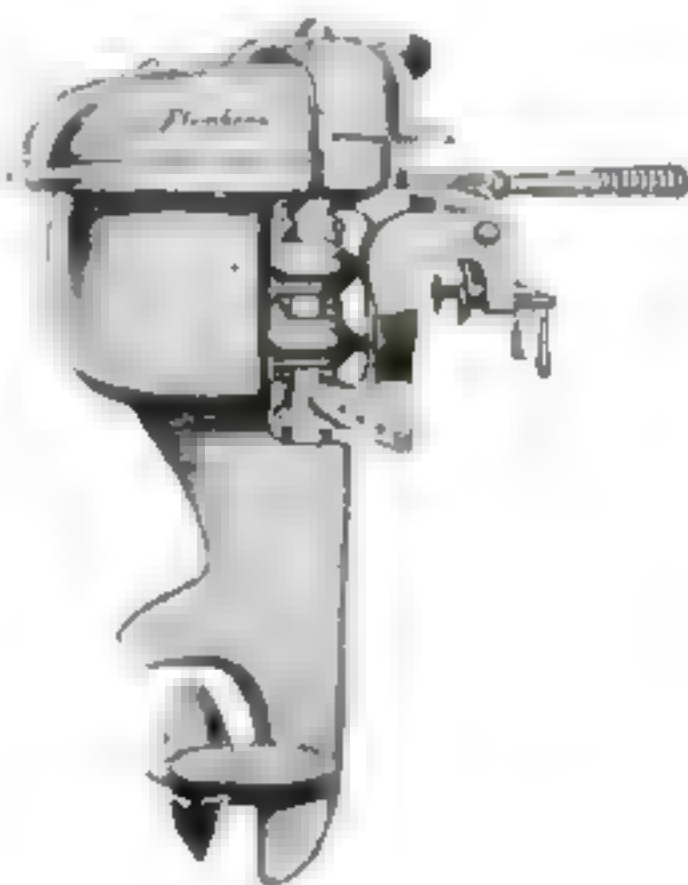


Dry Powder Urea Resin Glue



Makes Used Oil Good As New

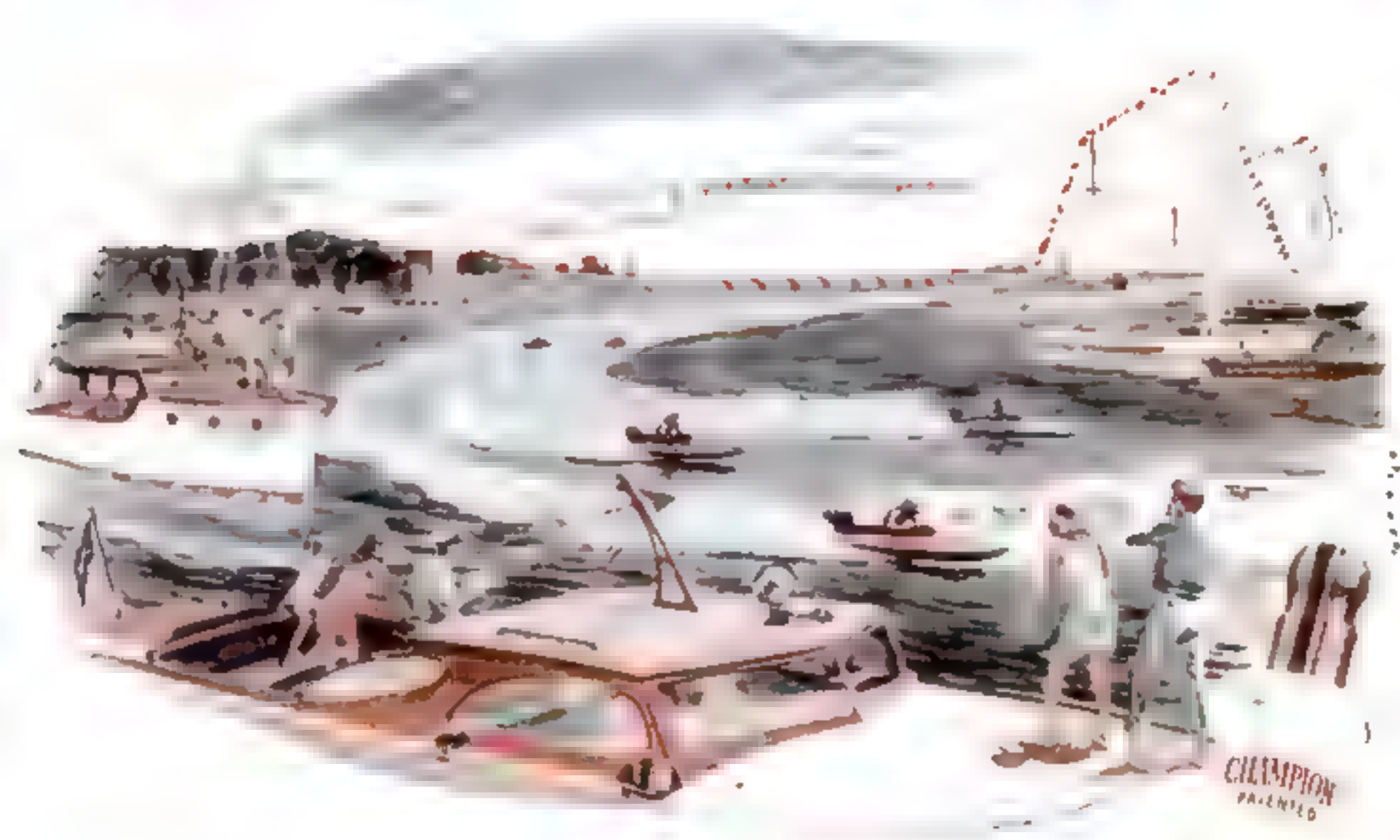
BUILT to restore used lubricating oil to the quality of new oil, this refiner not only removes solid suspended impurities, but also such harmful impurities as moisture, solvents and asphaltines. Made by the Youngstown Miller Co., of Belleville, N. J., it re-refines by contact filtration, the process used in refining crude oil. A model adaptable to Diesel locomotive drainage is now in production.



Easy-to-Service Outboards

FIFTEEN percent lighter than prewar models, each of three Flambeau outboard motors (like one above) features the exclusive two-piece, over-all motor housing and removable cylinder sleeves and bearings.

Here's why most boat owners prefer Champion Spark Plugs



THEY'RE DEPENDABLE!

Owners of power boats of all sizes and types take deep pride in the performance of their craft. As a class they are experts on engine performance, and to them spark plugs are a matter of primary importance. That's why it's worthy to note that these experts—in both racing and cruising—prefer dependable Champion Spark Plugs in overwhelming majority. This preference is also expressed by most motorists. Champion Spark Plug Company, Toledo 1, Ohio.



FOLLOW THE EXPERTS . . . DEMAND DEPENDABLE CHAMPIONS

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JUST USE THIS, MISTER



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film is to use Du Pont
No. 7 Polish. It saves time
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a wonderful improvement
in the car's appearance.
Try a can today.



Better Things for Better Living
...Through Chemistry

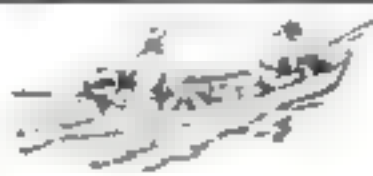
NO. 7 POLISH



You don't have to be an "Old Salt" to maneuver a Johnson powered boat. Johnson's 360° Steering and Reverse make it easy to get in and out of tight places.



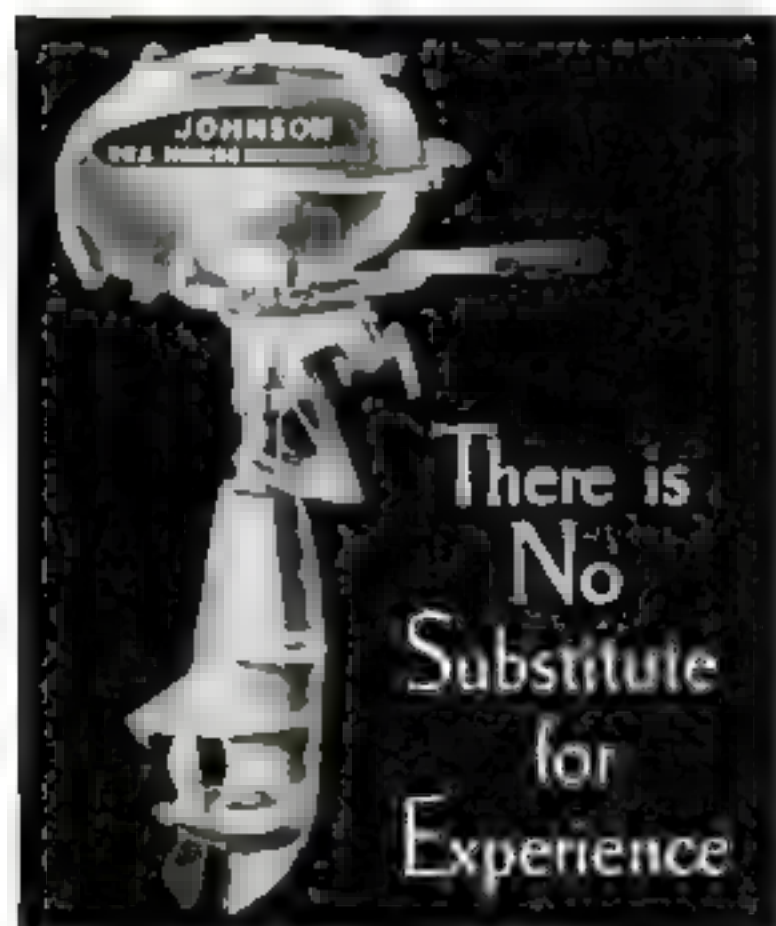
With Johnson's Dual Carburetion you can throttle down to a crawl and get the same sweet performance as at high speed. Rotary valve carburetion takes over automatically.



Third port operation at high speed lets you really step out when your throttle is open. Power... smooth power... without fussing. Hour after hour, you GO!

WWM • S.H.R.
WWWWW • S.H.R.

Two power impulses per revolution instead of one—a liquid flow of 8,000 impulses a minute in a Sea-Horse! That's Alternate Firing, developed and perfected by Johnson.



This is the famous Johnson Sea-Horse Model TD—the outboard motor that "has everything"... It develops 5.0 O.B.C. CERTIFIED brake horsepower at 4000 r.p.m. It is built with all the major refinements (27 of them) that make for outboard quality. It is prized above all for its **DEPENDABILITY**. And, of course, it is the motor that gives you "The Big Three" of outboard motoring—Johnson Perfected Alternate Firing, Reverse and Dual Carburetion.

FREE HANDY CHART. Write for your copy of the new Sea-Horse Handy Chart which gives complete specifications on the 5 great models of the 1946 Sea-Horse line. **JOHNSON MOTORS, 500 Pershing Rd., Waukegan, Illinois**

JOHNSON BUILDS SEA-HORSE MOTORS ONLY—NO OTHERS

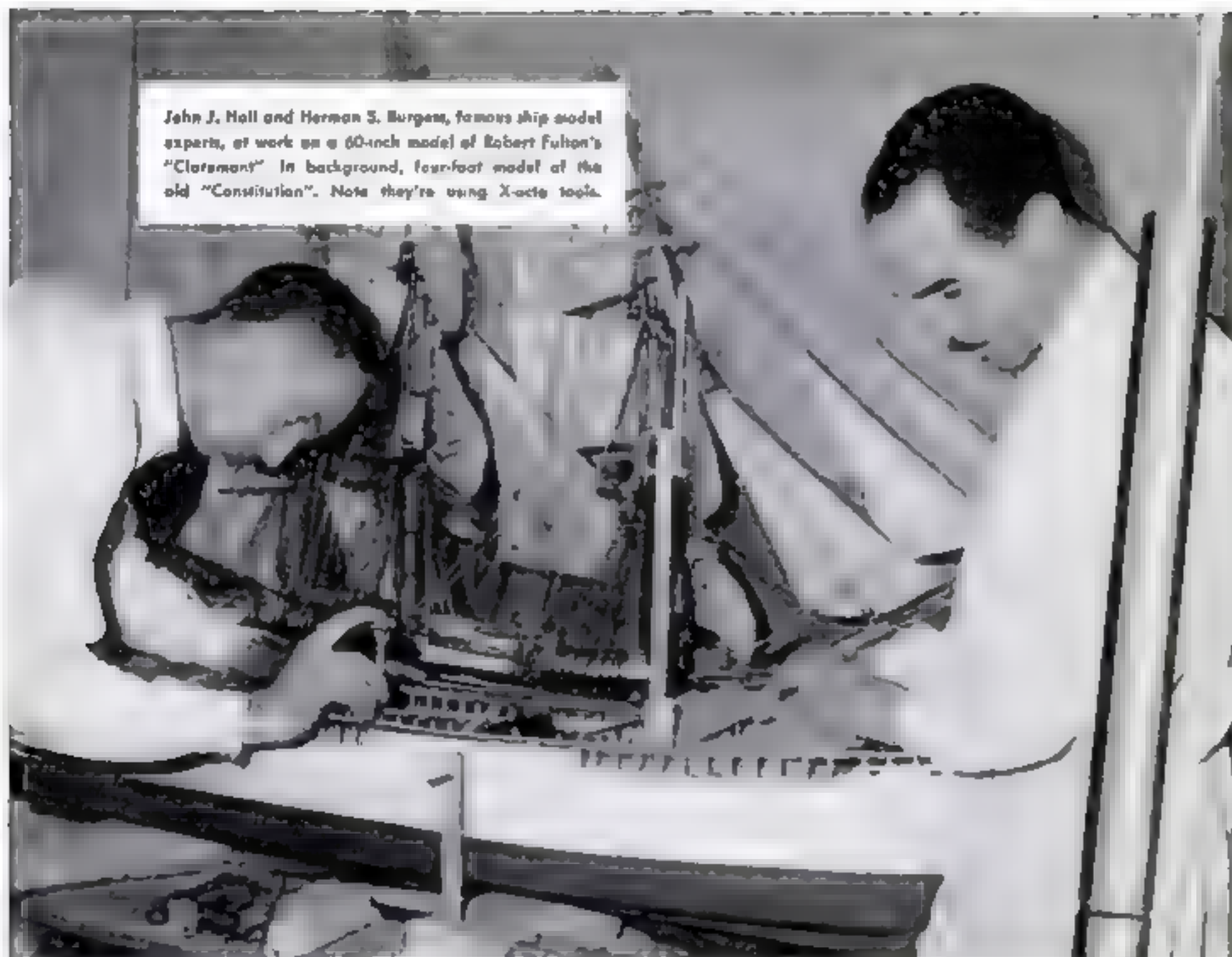


It took many years and many dollars to build the nationwide dealer organization that sells **AND SERVICES** Johnson motors. When you buy a Sea-Horse you know you've got a motor that can be kept in tip-top condition.



The new Sea Green Sea-Horses are being shipped—but the demand is the biggest in history. List your name with your Johnson dealer. Look under "Outboard Motors" in your classified phone book.

John J. Hall and Herman S. Burgess, famous ship model experts, at work on a 60-inch model of Robert Fulton's "Claremont". In background, four-foot model of the old "Constitution". Note they're using X-acto tools.



"You'll build better models with X-acto!"



"WE'VE used X-acto Knives and Tools for years . . . and we recommend them highly to all model builders," say President Burgess and Commodore Hall of New York's Model Schooner Club.

And that's advice worth heeding, for Hall and Burgess boats are consistent winners at the annual Model Yacht Regatta in Central Park.

Whether you are an amateur or a professional . . . a model builder, whittler, or the family Mr. Fix-it, you'll do a slicker job, and quicker, with these removable blade hobby knives. And now that the war is over, X-acto Knives are *all-metal*—no more substitute plastic!

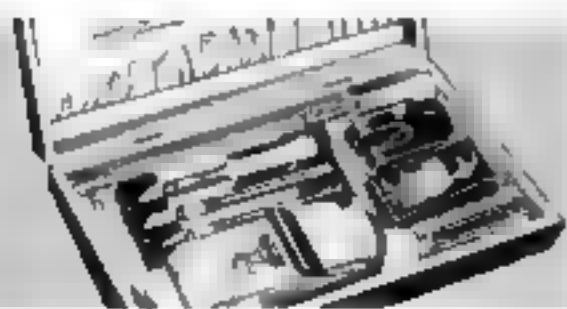
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Knife . . . **50c**
With 5 assorted blades,
\$1. Other X-acto
Knives, Tools, Chucks,
50c to \$12.50.



It's Got Everything! No. 85 X-acto Tool Chest—3 all-metal knives; full assortment of blades and X-acto hobby tools; complete in wooden chest, \$12.50. Also No. 84 Set, \$7.50

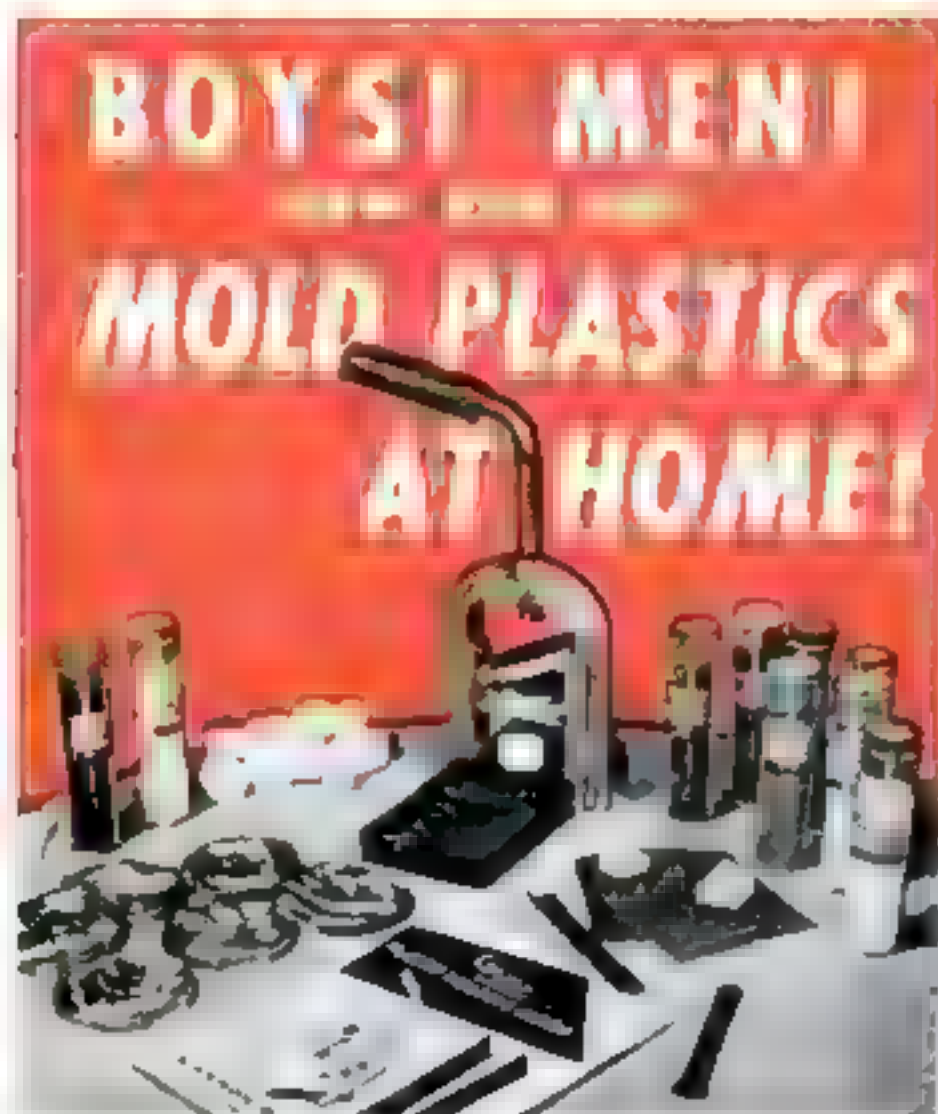
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Picking Cranberries by Suction

THE machine being demonstrated above by its inventor, A. V. Anderson, Grayland, Wash., picks cranberries by suction more than twice as fast as they can be picked by hand. Moreover, a cleaning attachment draws off the weeds and dust before they go into the rubber-lined container.

Increased yield is expected from the fact that suction picking disturbs the buds less than hand picking. Vital part of the picker is a special hose developed by the U. S. Rubber Co.

Modifications of the machine are at present being made to adapt it to bogs in Massachusetts and New Jersey, where the vines grow longer and the cranberries cling tighter than in the West.

Oil Treatment for Army Germs

THE Army Medical Department is trying out an oil treatment of GI blankets and barracks floors to prevent respiratory diseases. The treatment is based on the theory that a light oil with a paraffin base will trap dust and germs by absorbing them.

It is spread on the floors and applied to blankets in a paste that is odorless and colorless, spreads evenly, and is readily absorbed. The weight of a dry blanket is increased less than two percent by the process, which takes only a few extra minutes. Added advantage for GIs is the fact that an oil-treated floor needs only to be swept, not scrubbed.

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LOOK at this teen-age youngster! Flying Aeronca is as easy and effortless for him as driving a car is for you. Today men and women from 16 to 60 are enjoying the fun and relaxation of flying Aeronca—the new way to go places fast!

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Here's All You Do!

Learning to fly Aeronca is as easy as learning to drive a car. A skilled instructor goes up with you in a plane equipped with dual controls. He's right there with you to correct every mistake until you master the simple fundamentals. Thousands sold in 8 hours, or less. Why not see your Aeronca dealer today?

Over 1000 Aeronca Qualified Dealers to serve you.

AERONCA *America's No. 1 Low Cost Plane*

YOU CAN TAKE IT WITH YOU!

AND TRAVEL IN COMFORT WITH KARI-TOP^{PATENTED} AUTO LUGGAGE CARRIER

It's here!—The luggage carrier you've been waiting for! Ideal for every Hunting, Fishing and Camping trip. Adds EXTRA, FULLY ENCLOSED, WATERPROOF, DUST-PROOF space to carry all the things you'd like to take on a trip. ON IN A MINUTE • NO SUCTION CUPS • WON'T MAR FINISH • FITS ANY COACH OR SEDAN • CAN'T SHIFT • HOLDS UP TO 10 SUITCASES.

RUBBER COVERED CHANNEL HOOKS grip moulding firmly and securely without marring finish or interfering with doors. Springs give even tension.

LOAD CAN'T SHIFT. Straps, fastened to bottom of bag, hold it firmly to car whether loaded or not. Straps across top prevent shifting of load.



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OF UGLY WEEDS!**



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Harm Common Lawn Grasses!

NO MORE back-breaking digging! Destroy ugly leafy weeds with WEED-NO-MORE!

The 8-ounce lawn-size package treats 1600 square feet! Now you can enjoy a beautiful weed-free lawn for only \$1!

WEED-NO-MORE kills dandelion, plantain and other ugly weeds—yet won't injure soil.

Get it today! Rid your lawn of ugly weeds for only \$1. Just spray on... WEED-NO-MORE!

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THE AMAZING NEW WEED KILLER

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faster, with a*

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Trade Name Reg. U.S. Pat. Off.

The Vibro Tool complete with 22 accessories for engraving on steel, jewelry, decorating glass and plastics, carving on wood, cutting out patterns from cloth, rubber and cardboard, tooling and embossing leather, and many other jobs; plus sharpening stone, conveniently fitted into handsome hardwood, natural finish, hinged box... **\$16.50**



The Vibro-Tool operates by vibration... 120 vertical strokes per sec.; 60 cycles AC. 110 V.

The Vibro-Tool may be purchased separately, with engraving needle for... **\$7.50**

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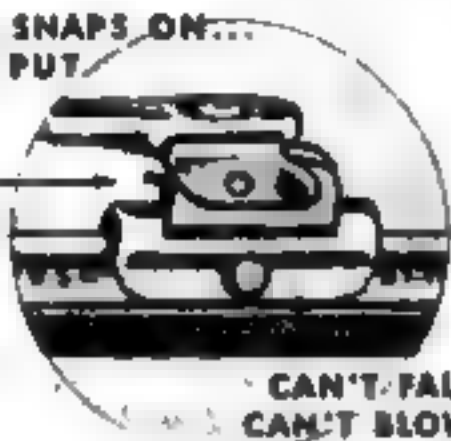
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"Dead-Locker"

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ARMS and BLADES

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STAYS PUT

FINGER-
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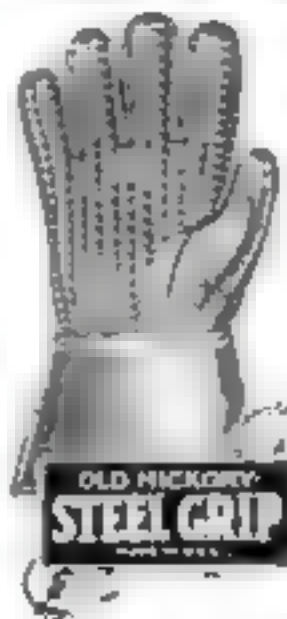
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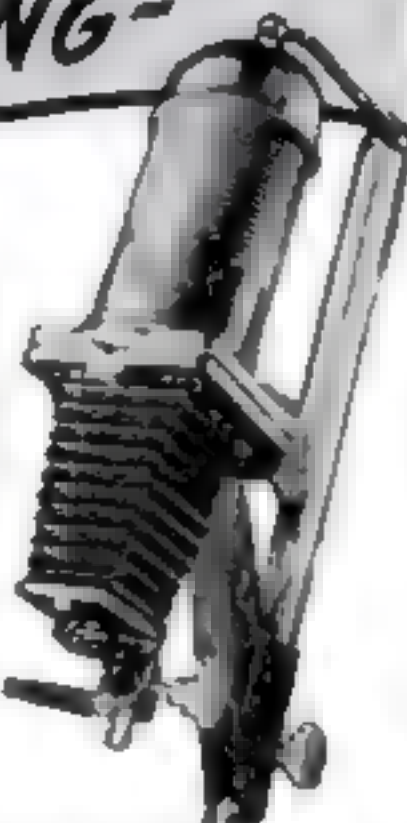


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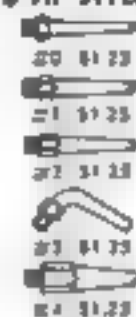
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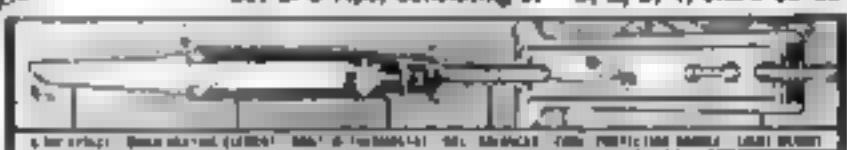
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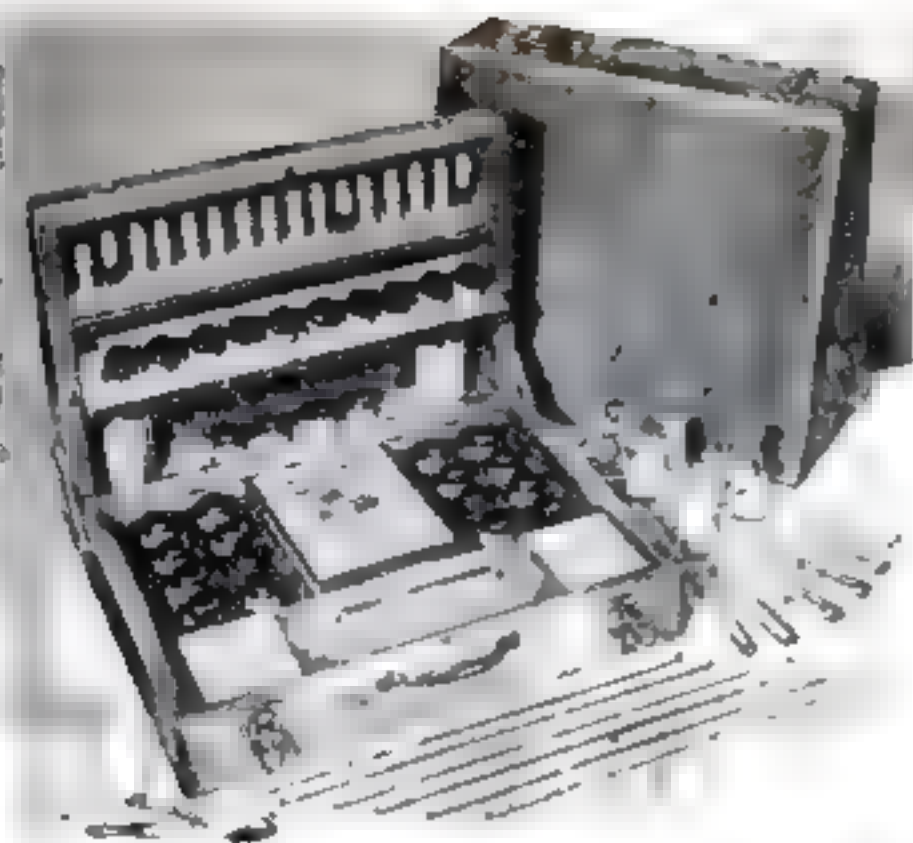
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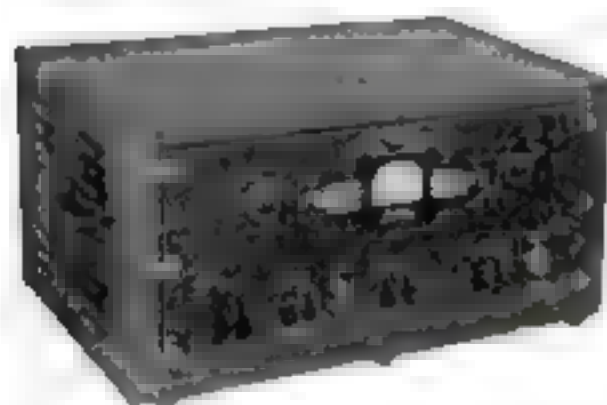
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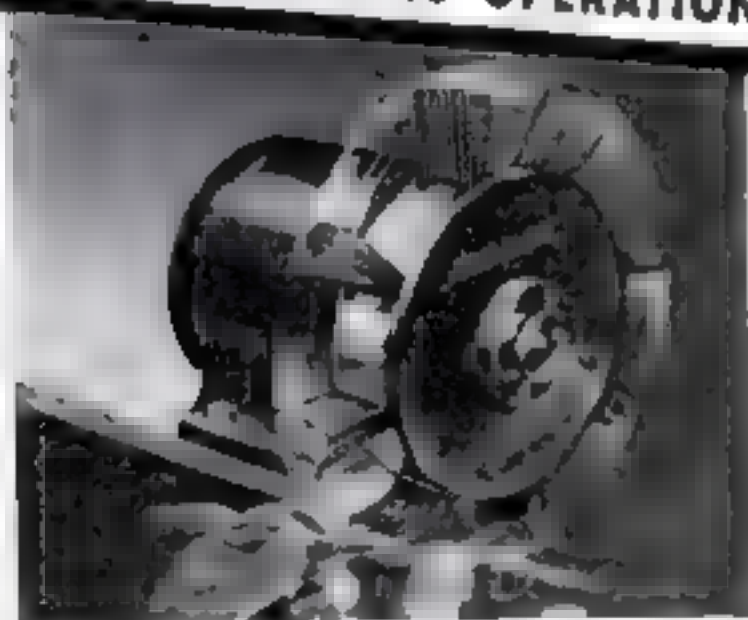
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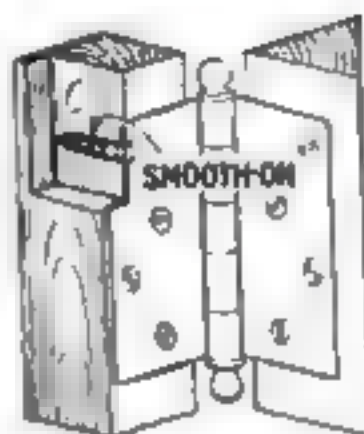
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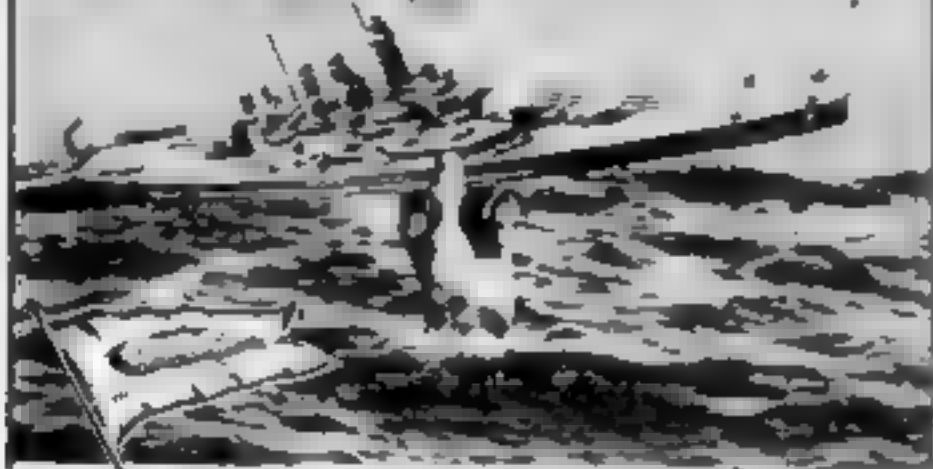
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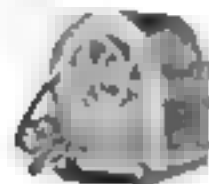
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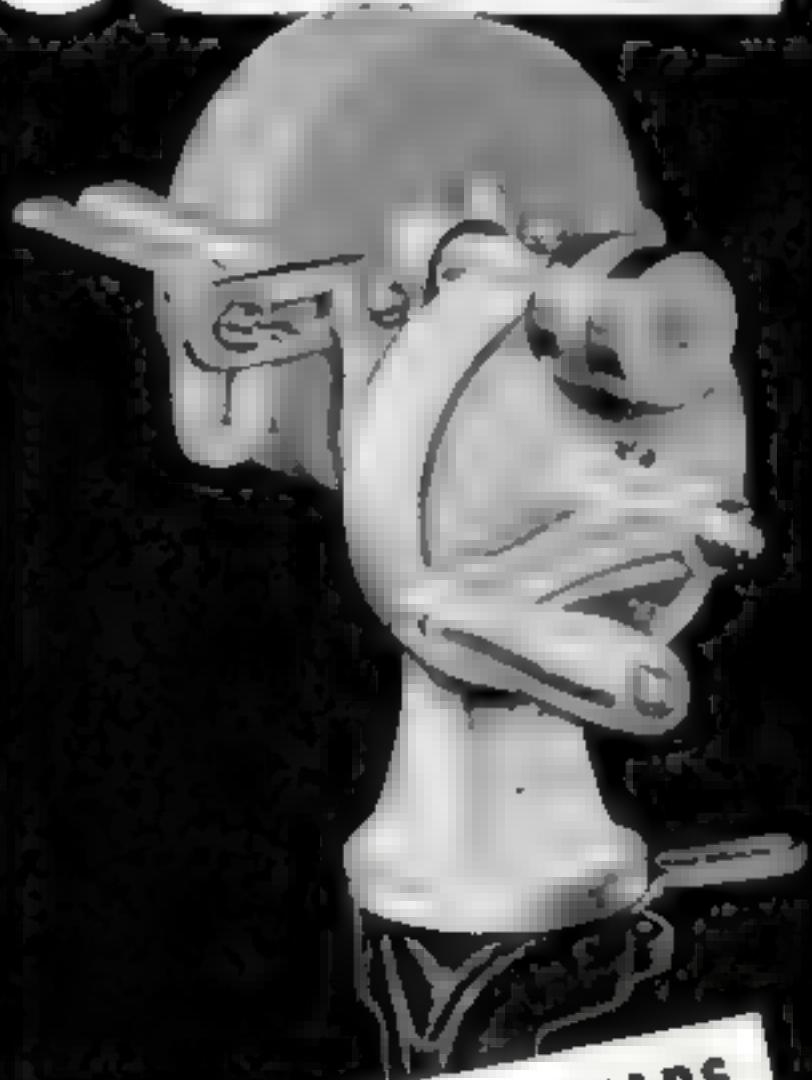
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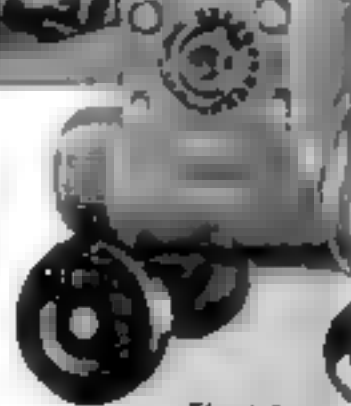
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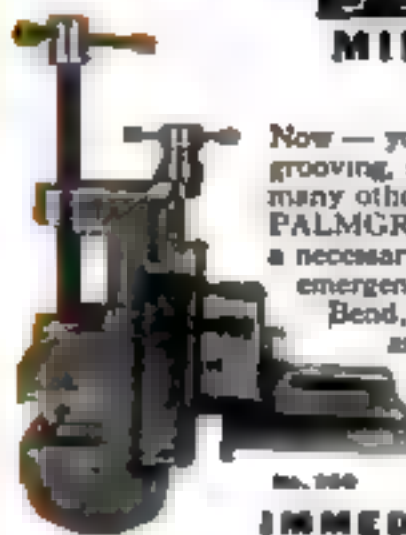
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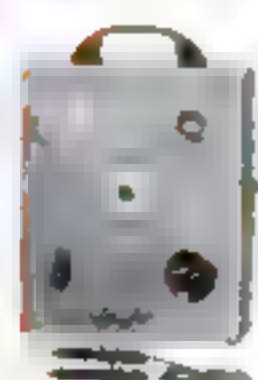
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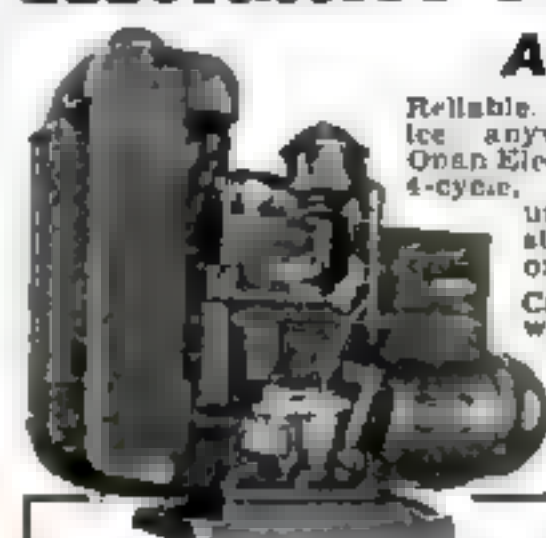


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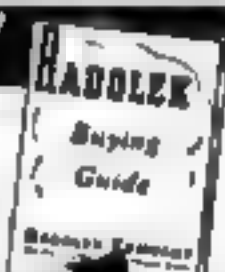


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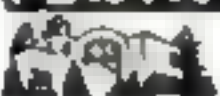
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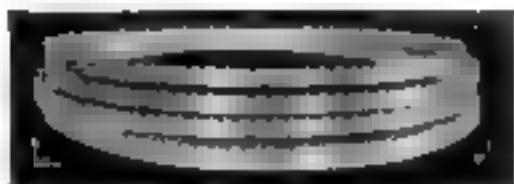
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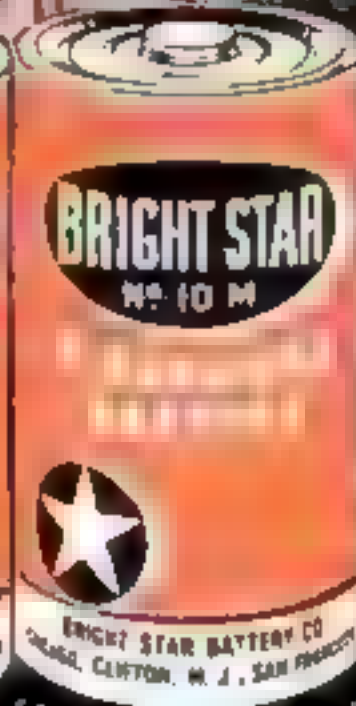
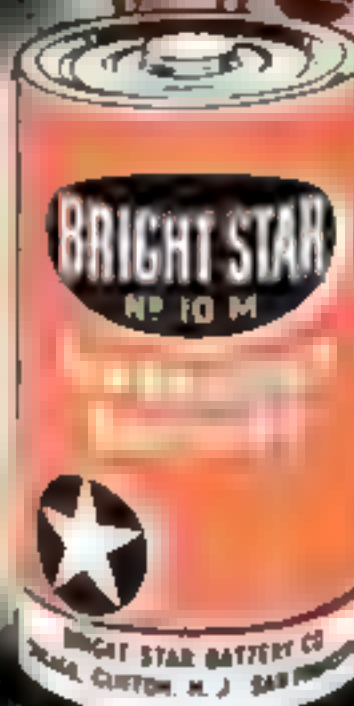
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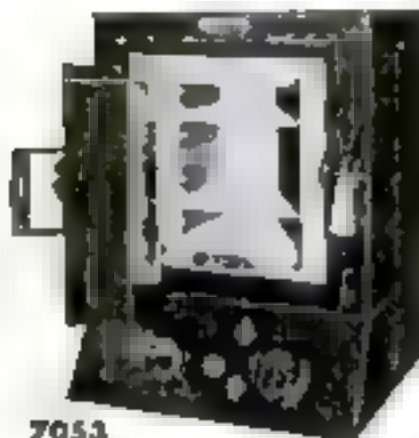
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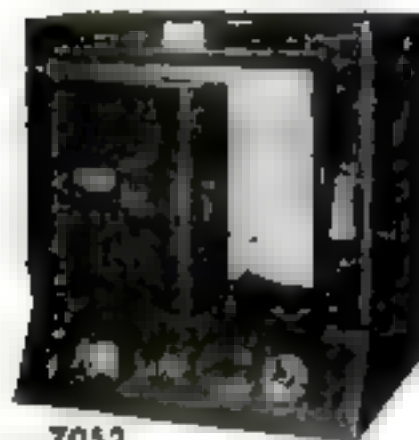
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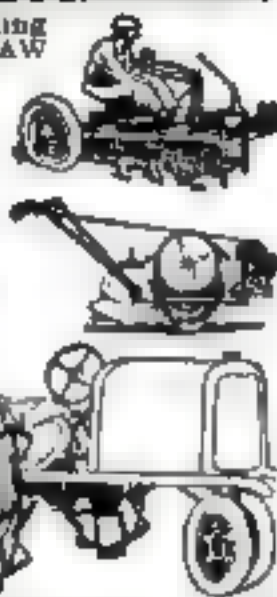
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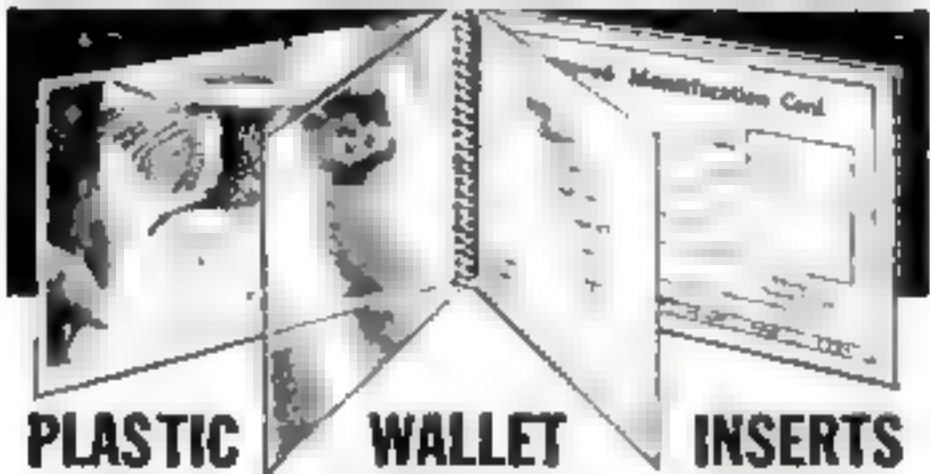
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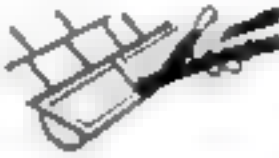
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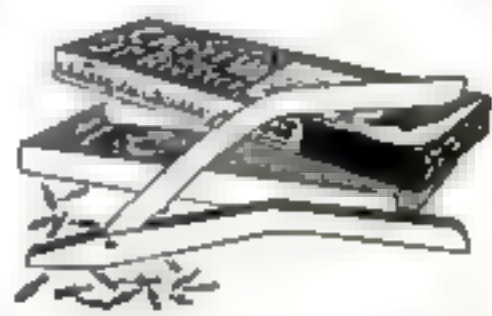


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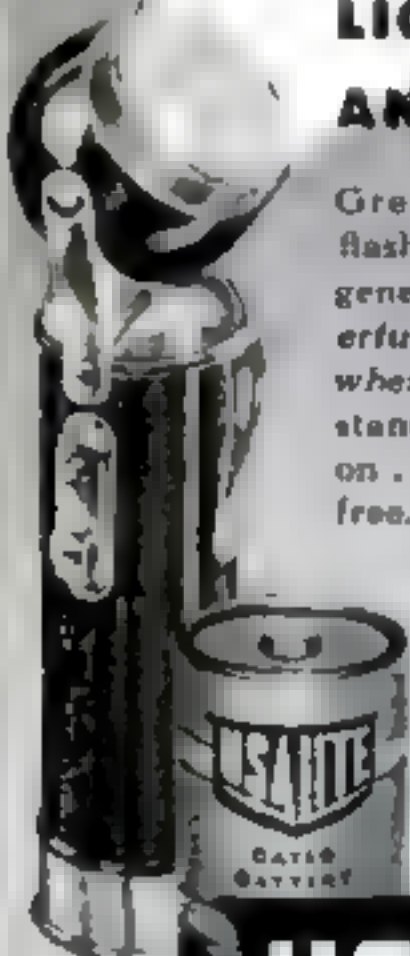
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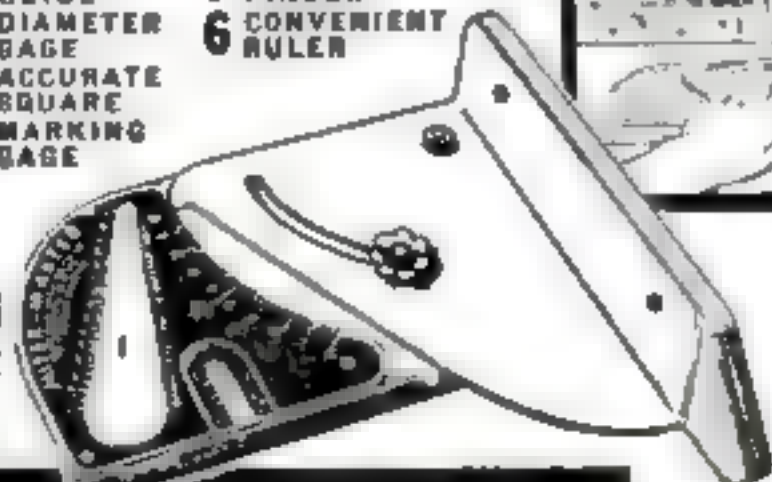
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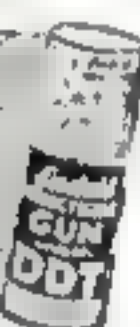


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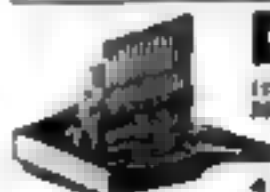
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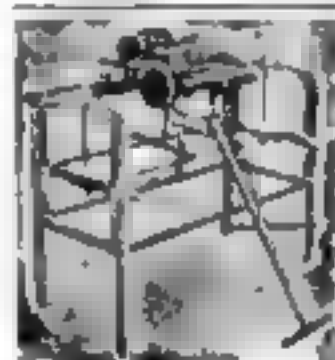


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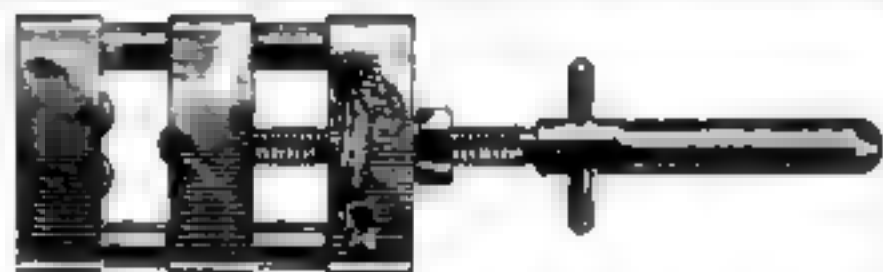
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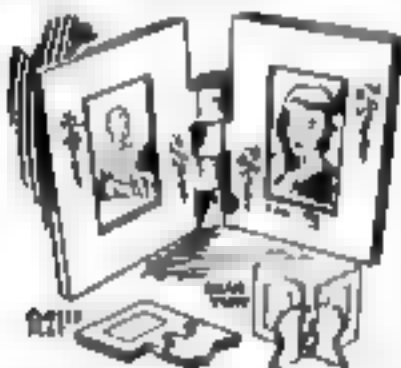
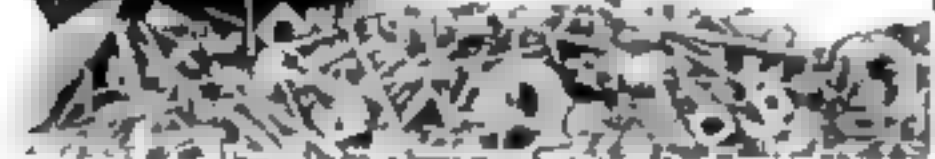
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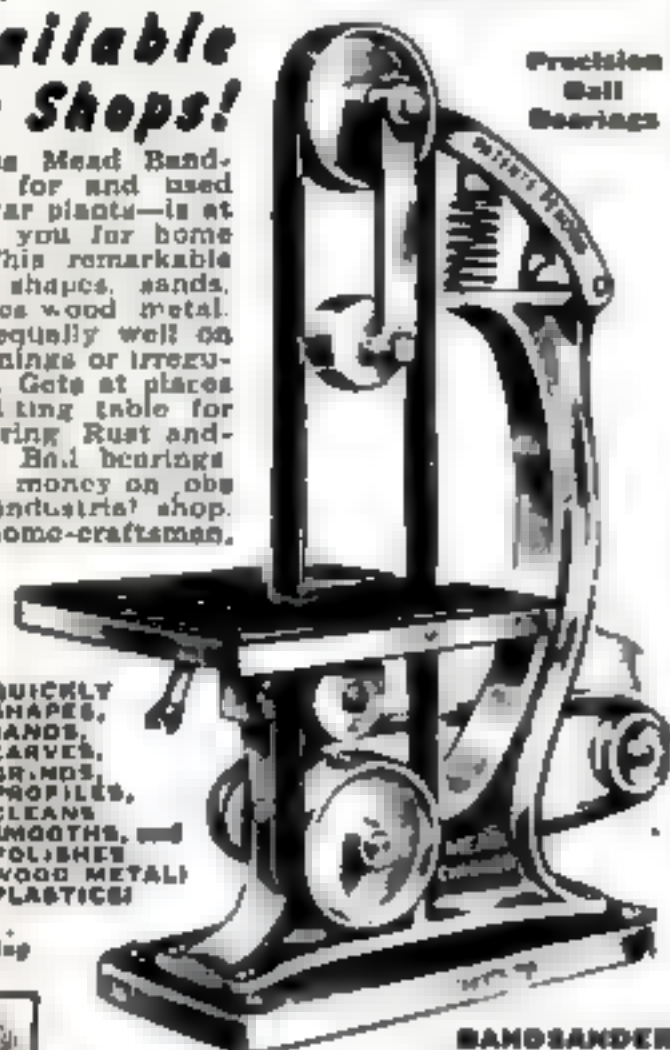
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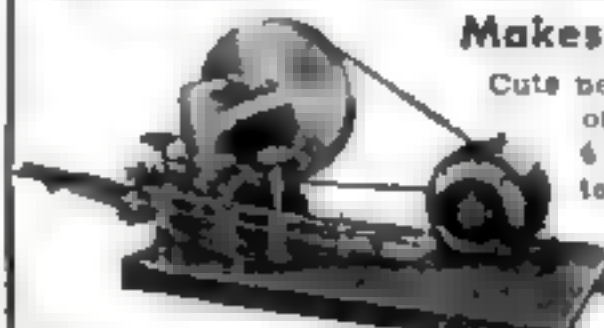
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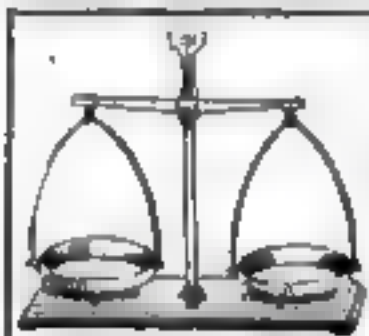
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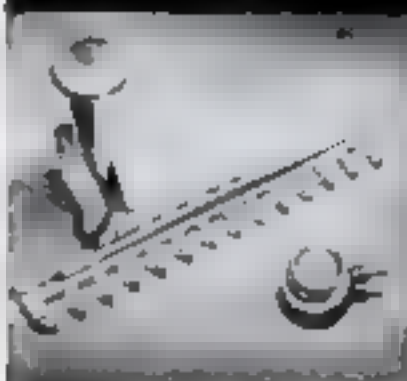
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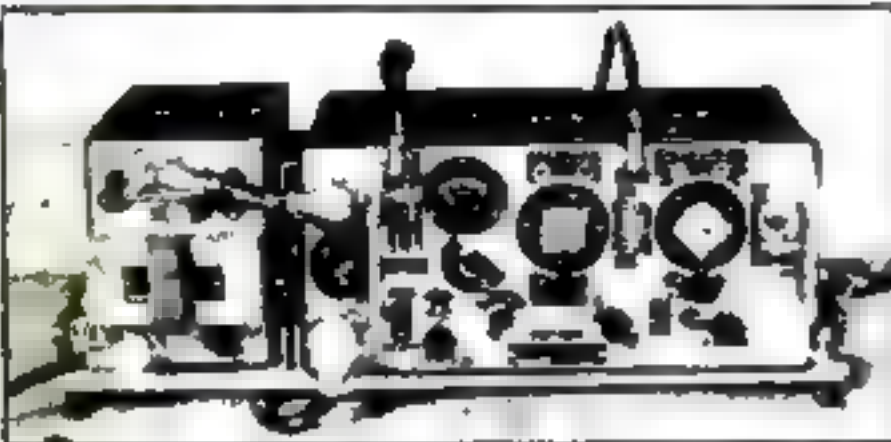
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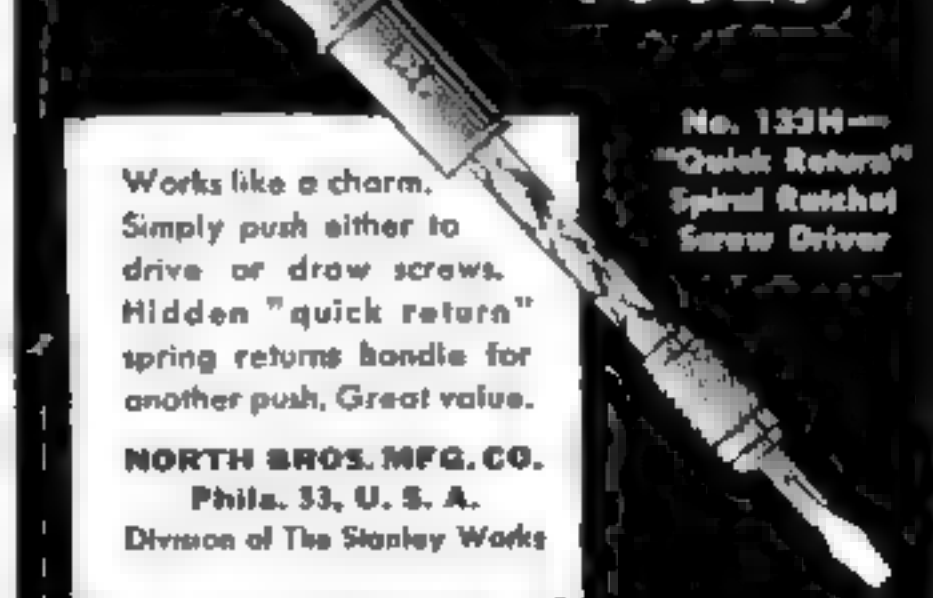
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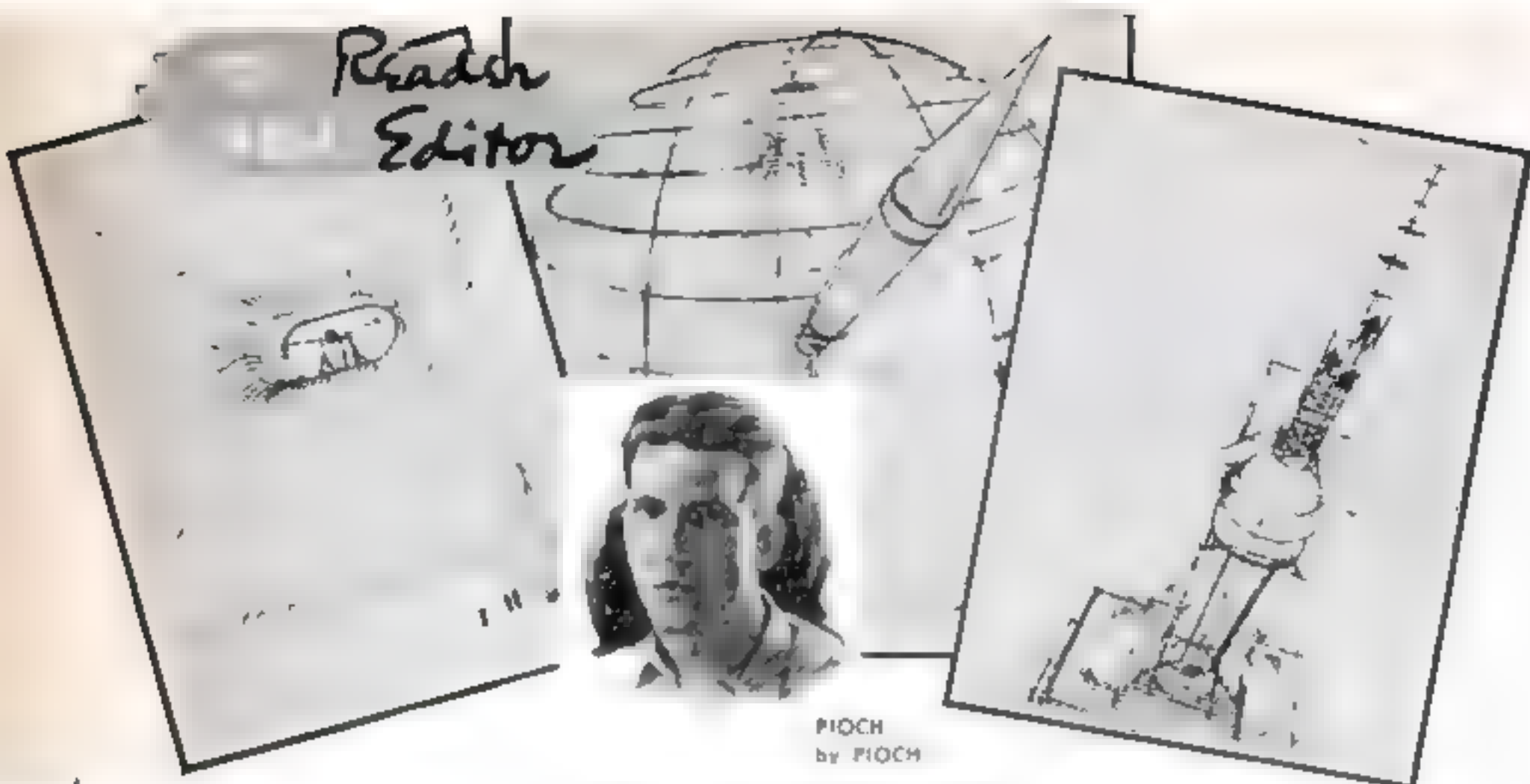


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JULY 1946 253



Working Sketches for PSM Covers

A MAGAZINE cover has many jobs. It must identify the magazine. It must signal old friends that a new issue is out, and gain new readers by its timeliness in their interest. As the show window of the magazine, like the displays at the main entrance of Macy's, Marshall Field's, or your local hardware store, it must indicate the character of the magazine and give a clue to its contents.

It should be familiar—yet new. It should catch the eye of the racing commuter without shocking the delicate after-dinner sensibilities of the settled subscriber. Of course, its subject should appeal to a wide variety of persons and its artistic handling should be nothing less than perfect.

That, however, is only the half of it for *Popular Science Monthly*. For you readers have an uncanny eye for accuracy. In addition to all the usual qualifications, PSM covers also have to have a technical faithfulness that makes a blueprint look like a child's drawing.

A PSM cover must have a subject that is important as well as interesting or decorative. The cover of this issue, for example, is really a full-color frontispiece for the story about what wind tunnels mean to you as an air-line passenger, a private flier, or even a taxpayer who licks an airmail stamp.

Like the Wac Corporal, which soared across the May cover, and the helicopter view of the Empire State television antenna

on the June cover, the cave of the winds on this July cover is the work of an artist named Ray Pioch, who understands PSM's necessities of art with accuracy.

Pioch, now 29, has been handling a brush since childhood. An art apprentice on the *Toledo Blade*, he studied drawing and painting nights in Toledo, and in Chicago at the Art Institute. He worked for General Motors in the department where the shape of cars begins. In the Navy, he served in the famous Training Aids Development Center, which did so much in the conversion of civilians into the men who watched the dials in the turrets and control rooms.

A Pioch cover is engineered as carefully as a railroad curve. And the cover on this issue was an engineering exercise in perspective. There was only one way to give you an idea of the size of this biggest man-made nostril, and that was in the comparative size of the men standing just inside the door and those working under the real airplane in the test section.

I can testify that Ray Pioch has conveyed the impression of gloomy immensity that envelops anyone who stands inside this tunnel, because I was there. As an artist, he has created a feeling no camera could capture, with a technical accuracy a photographer would envy.



This One



U6JG-XAU-BSA4



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YOU can't look an engine in the teeth, but you can tell its age by its performance—and new Sealed Power Piston Rings can knock years off its age, increasing horsepower by as much as 20% to 25%, saving oil, saving gas, and lengthening engine life.

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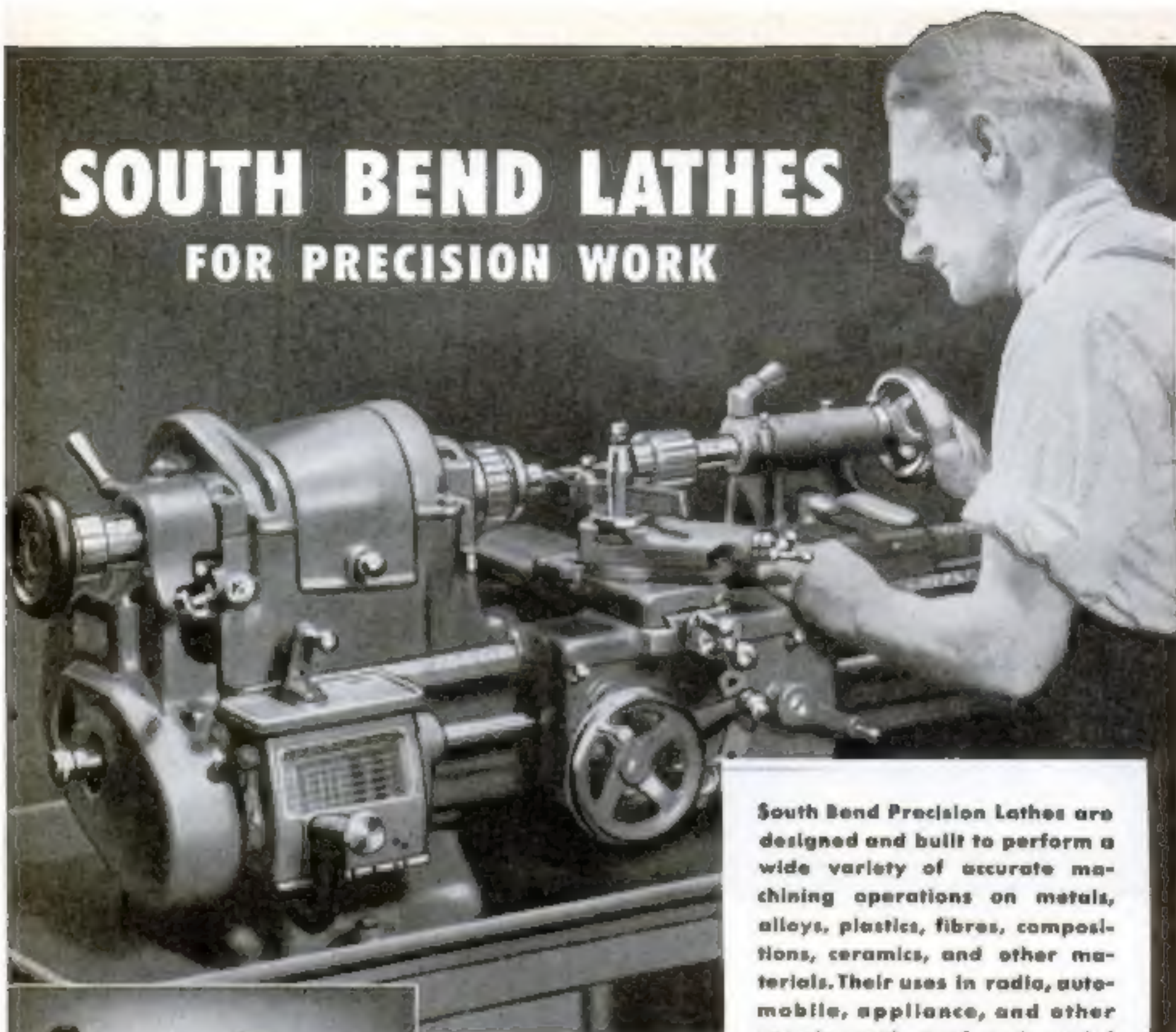


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from the sky . . . See mad Kamikazes crashing the flight decks of Carrier Bunker Hill . . . See the Navy ferrying our armies to invasion shores, even across the Rhine! . . . See Halsey's Third Fleet blasting the prize Jap battleship Yamato!

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